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In This Issue . . .

- Transistorised Audio Pre-amplifier Design.
- Digital Electronics in Industry and Science.
- Square-Wave Testing.
- Camera View — a new feature.
- Mobile Communications — Part IV.
- Serviceman's Column, Listening Post.

PUBLISHED MONTHLY IN THE INTERESTS OF THE N.Z. ELECTRONICS INDUSTRY FOR ALL LEVELS, FROM PROFESSIONAL TO AMATEUR.

VOLUME 20 NUMBER 6

AUGUST 1, 1965

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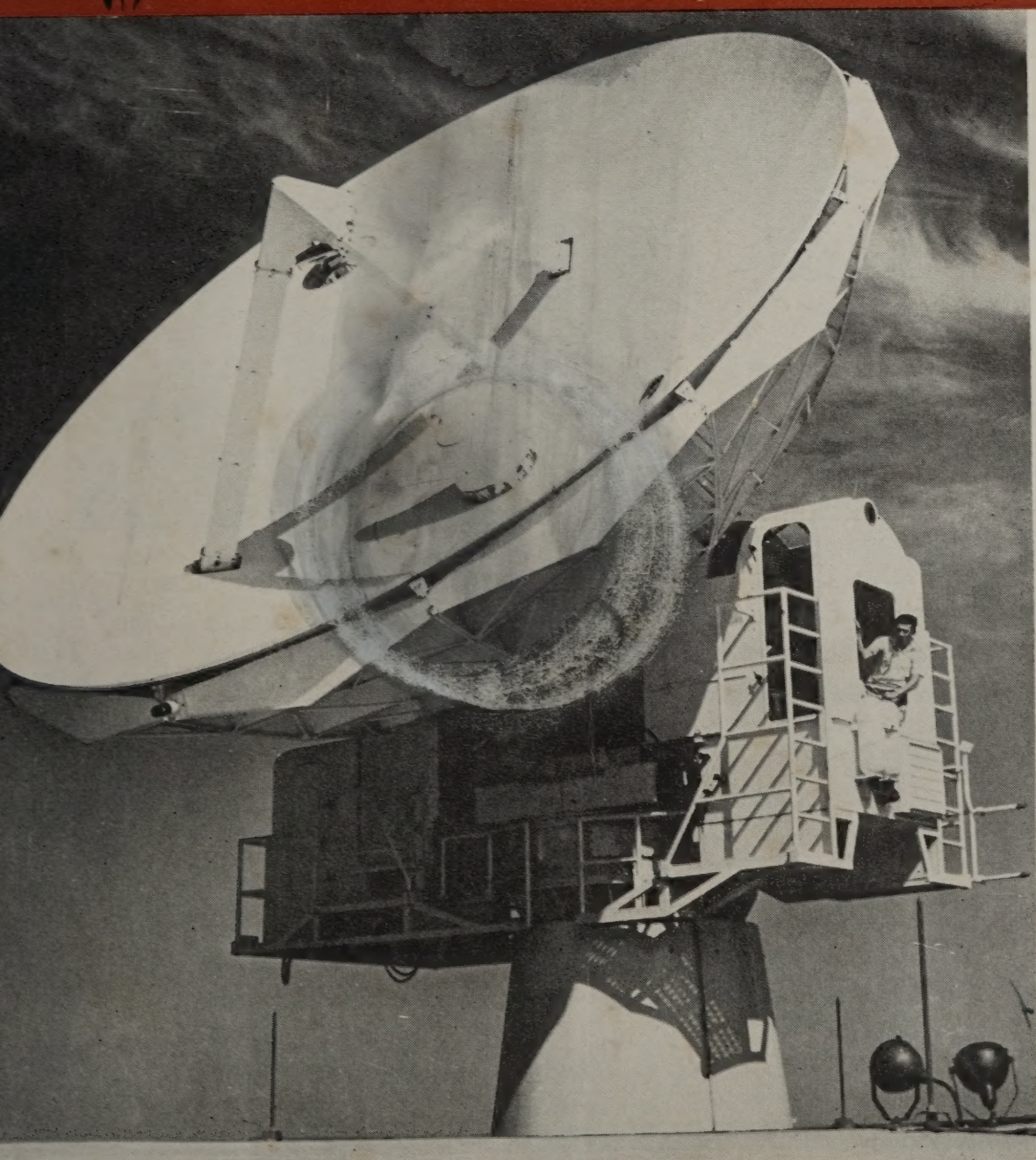

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Ken G.

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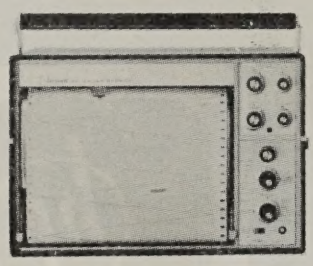

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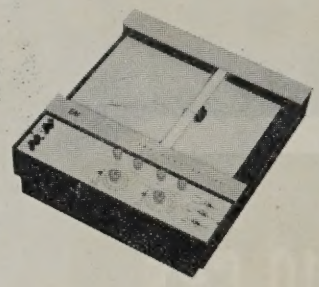

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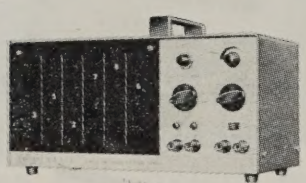

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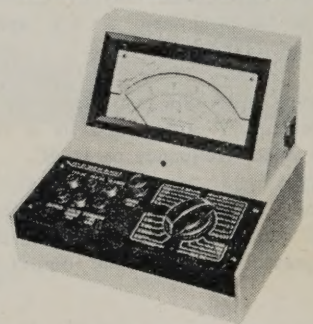

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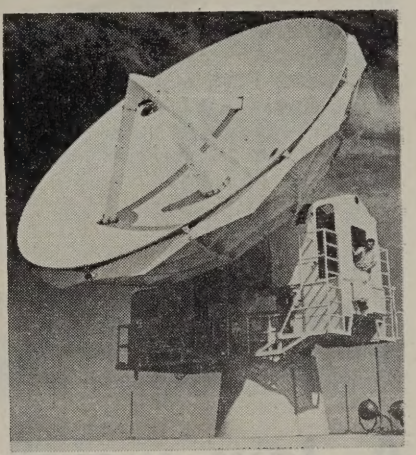

More than 100 men and women employed by Amalgamated Wireless (Australasia) Ltd., at Carnarvon, Western Australia, played an important part in tracking the Gemini IV space capsule. It was from this capsule, piloted by American Jim McDivitt, that fellow astronaut Ted White emerged in the historic "walk in space". Photograph shows one of the ground based installations operated by AWA. It is a 40-ton antenna system with a 29 foot diameter parabolic reflector of the precision radar system which has a range of 32,000 miles.

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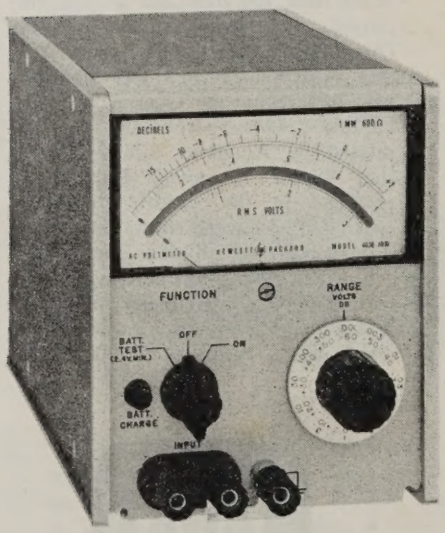

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Letters from Readers

Sir,

I read with great interest Commander Beere's comments on my article on technician training. The points he raises would require at least another article if they were to be replied to in any detail, however I would like to reply briefly to the points raised.

In saying that the NZCE takes about the same amount of time and study as a B.Sc. degree I perhaps did not make my meaning completely clear. Both the NZCE and the B.Sc. are a three year investment in training. Although the NZCE consists of an average of 15 hours of formal training a week, it is supplemented by practical training at the same time. A student taking a B.Sc. degree would, over the three years, probably average out just a little higher than this. It is difficult to compare the training received at University with that for the NZCE since they are about different subjects, but a good pass in the NZCE will exempt a student from about two years of the B.E. course. The point facing the prospective student is whether to spend his three years getting a degree with resultant professional status, or an NZCE with no status whatsoever. I am aware that School Certificate is the required minimum level for entry to the NZCE course, but many students do hold higher qualifications, so that many who could manage a degree are deliberately choosing the NZCE. It seems hardly fair that they should be penalized for this.

I cannot agree with Commander Beere that the State Services Commission have helped to retain the standing of the term Technician. In fact to my knowledge they have been well to the fore in adulterating this term. The public service is full of examples of the term Technician being used as a means of granting people, with only trade qualifications or even lacking any formal qualification, a salary increase in order to retain their services. The term Engineer has been similarly used, as in many departments it is used to describe people who do not hold a professional qualification. It would appear that the criterion is the job done rather than the qualification held, and there are arguments that could be mustered to support this view. In any case the term Technician Engineer has been recognised by the IEE who have been active in encouraging the newly formed Institution of Technician Engineers (London), whose members are entitled to so call themselves.

It is a pity to see the multiplication of institutions for the electronics branch of electrical engineering, because these can only weaken the total position of all in it, nevertheless a Technician Engineer would in my opinion be better off as a full member of his own institute than second class member of either the IERE or the IEE.

There appears to be general dissatisfaction with the term Engineering Associate at present used in N.Z., because it neither describes the work of those so registered, nor does it have any meaning in itself. Technician Engineer has a meaning defined clearly by the Joint Engineering Council, and carrying with it a status clearly merited by those who hold registration under the Engineering Associates Act.

V. M. STAGPOOLE.

CAMERA VIEW

We introduce this month a new feature that will present to our readers various facets of companies in the electronics field in New Zealand. Our intention is to highlight some special feature of the company under view — its production ability, technical aid facilities, laboratory equipment, unusual expansion — and bring it to the notice of our readers. Our preliminary list contains firms both large and small, at various stages of development, representing a cross-section of the expanding electronic industry.

Within this broad outline the general theme is designed to provide a report of technical interest.

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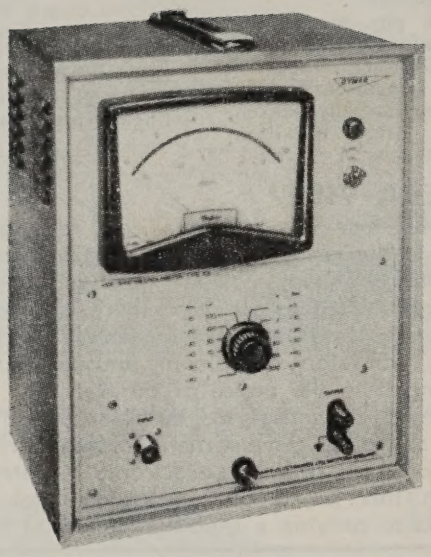

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CENTENNIAL OF THE I.T.U.

In recent years, most people associated with the electronics industry have come to know of the existence of several international groups, which are responsible for setting and controlling standards which affect many parts of the Electronics Industry. For example our television service operates to a specification established by the C.C.I.R. (Consultative Committee for International Radio), whilst the N.Z. Post Office operates in compliance with specifications set by the C.C.I.T.T. (The Consultative Committee for International Telegraph and Telephone), and on frequencies in accordance with regional plans established by the I.F.R.B. (The International Frequency Registration Board). Even the Amateur Radio Service has overall guidance from the I.A.R.U. (The International Amateur Radio Union). These various groups all come under the framework of the I.T.U. (The International Telecommunications Union).

It may come as somewhat of a surprise however that the idea of International co-operation has endured 100 years of relatively peaceful existence. To recapitulate a little, let us go back in time more than 100 years.

The first treaty on record designed to link the Telegraph system of two countries was signed on October 3, 1849 between Prussia and Austria. It provided for the connection of Berlin to Vienna by an electric telegraph line running alongside the railway. Similar agreements followed between other States, and in 1850 an Austro-German Telegraph Union was formed, which served its purpose well until 1872. During that time several meetings of the Union were held, and at the last one in 1857, in Stuttgart, a move was made to formulate some rules, which even today, are the guiding rules of the International Telecommunications Union.

During the same period a number of other European countries arranged agreements similar to the Austro-German Union and delegates from Belgium, Switzerland, Sardinia, Spain and France met in Paris in 1855 to form the West European Telegraph Union.

In 1852, Belgium, France and Prussia signed a convention to construct Telegraph lines to pass frontiers without interruption. By 1861 nearly a dozen more countries had also signed the convention. But still, the free flow of communications between countries was obstructed, and in 1865, the final and logical result was the need for improved co-operation. The French Government issued invitations to all major European Countries to attend a conference in Paris in March 1865 to negotiate an international telegraph system. Twenty countries attended, and formulated the First International Telegraph Convention. And thus the International Telegraph Union was born. The Union held Plenipotentiary Conferences in Vienna (1868), Rome (1871) and St. Petersburgh (1875) and at this last conference, so many important details were concluded that there were no further Plenipotentiary conferences until 1932. In fact the outstanding result of the St. Petersburgh conference was the re-drafting of the International convention when it was decided that technical experts would in future be responsible for keeping the Telegraph Regulations up to date. From 1879 until 1928, except for a period of 17 years centred on World War I, there were a number of administrative conferences, and by this time the membership of the Union had risen to more than 50 countries. At the Paris administrative conference in 1925, the decision was made to organise two Technical Consultative Committees, one concerned with Telegraphy — the other with Telephony.

During the period from 1900 onwards another problem of communication had arisen. The International Telegraph Union of the time was concerned mainly with matters of line and cable telegraphy. In 1903 Germany convened a Preliminary Radio Conference at which nine countries were represented and three years later, in 1906 the First International Radio conference was held also in Berlin, with 29 countries represented. Six years later, in London in 1912, the New Radio Regulations were approved. A third conference was held in 1927, this time in Washington, where delegates from 80 countries set up the C.C.I.R. and frequencies were assigned to specific radio services.

Finally, five years later, at Madrid, the International Telegraph Union combined with the International Radio Telegraph Union to form the International Telecommunications Union, and the Radio-Telegraph, and Telegraph conventions were combined to form the International Telecommunications Convention which today is still the charter of the present I.T.U.

Since 1932 there have been three other Plenipotentiary Conferences, at Atlantic City (1947), Buenos Aires (1952), and Geneva (1959). At Atlantic City, delegates saw the formation of the International Frequency Registration Board (I.F.R.B.) and a working agreement was reached with the United Nations. Thus since 1948, the I.T.U. has resided in Geneva operating with a permanent administrative council.

This year, to mark the centenary, two events are being held. There was a ceremony in Paris on May 17th, and a Plenipotentiary Conference is to be held in Montreux, Switzerland between September 14th and November 12th. In addition, the I.T.U. intends to publish a special book entitled "From Semaphore to Satellite".

Today the operation of Telecommunications throughout the world is governed by five basic documents, which will be revised at the forthcoming conference. These are the I.T.U. Convention, the Telegraph Regulations, the Telephone Regulations, the Radio Regulations and the Additional Radio Regulations.

I.H.S.

ENQUIRY CARD AD. 8

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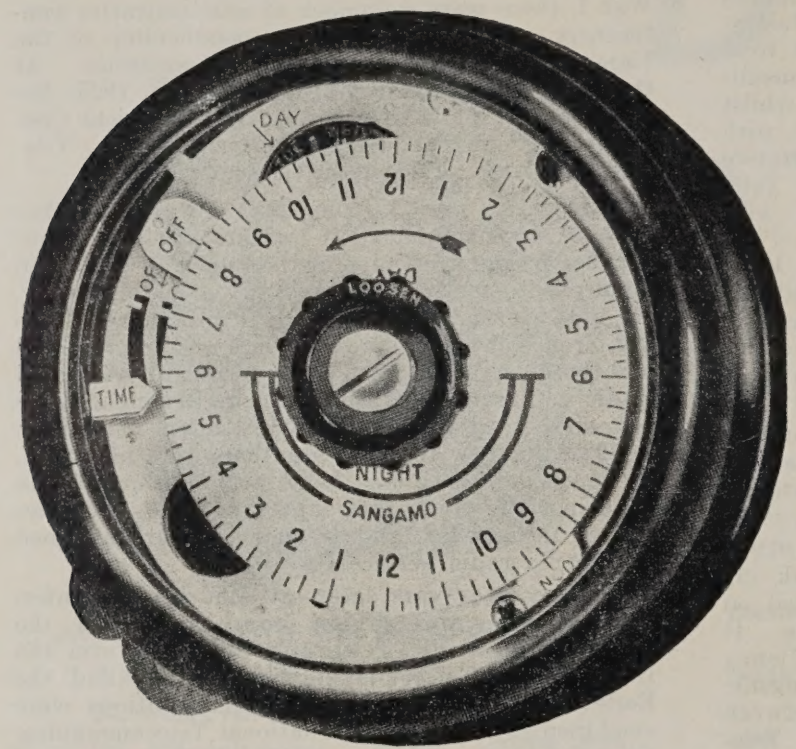

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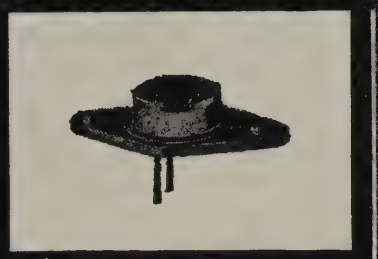

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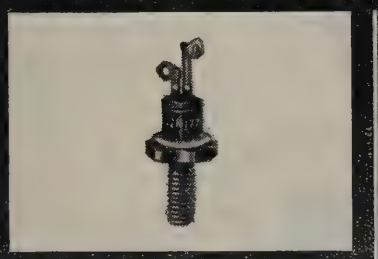

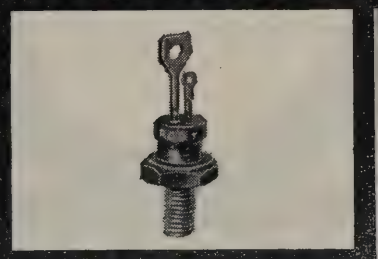

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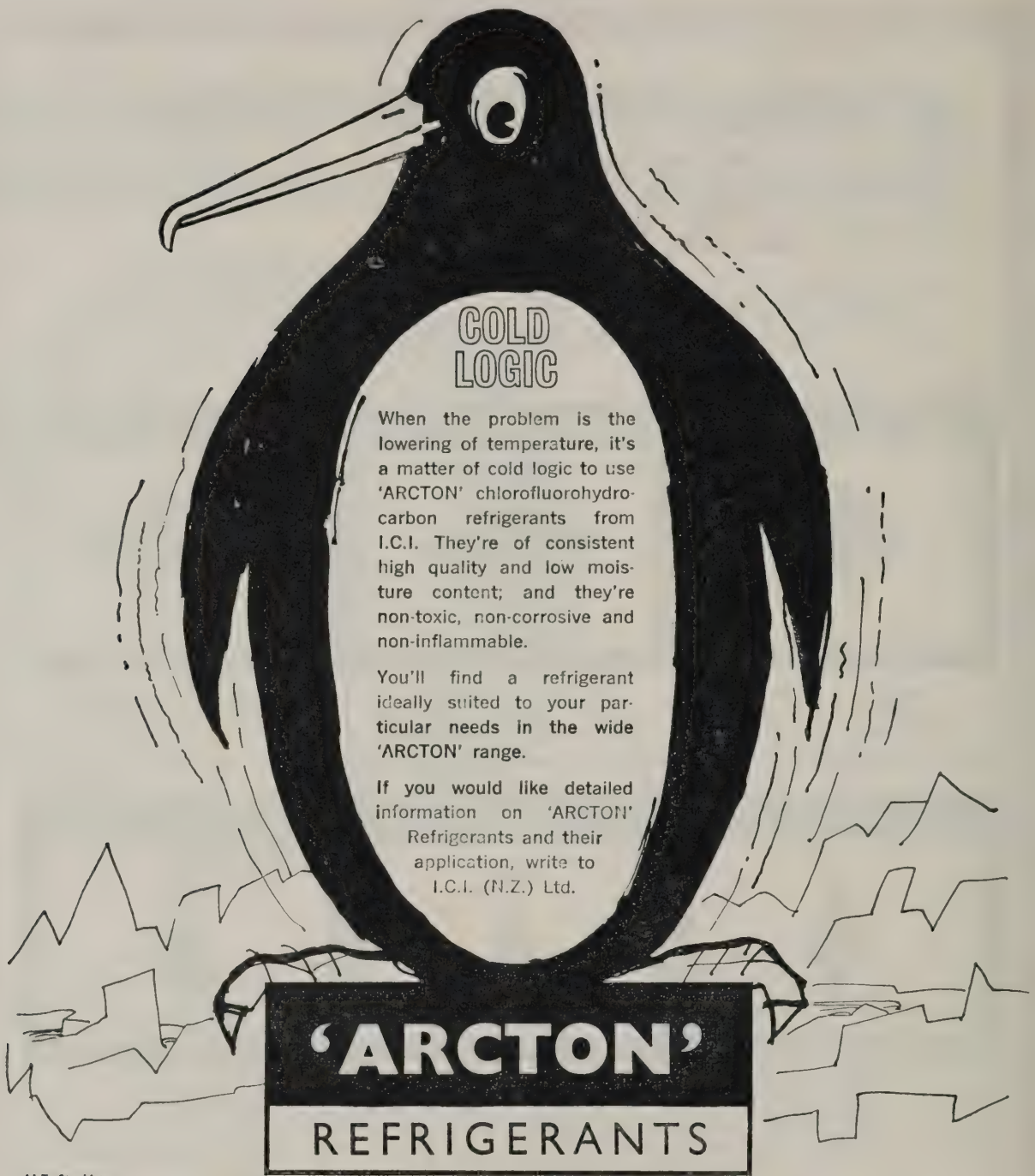
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DIGITAL ELECTRONICS

— In Science And Industry

by W. P. Gabriel

Physics and Engineering Laboratory,
D.S.I.R.

There is a wide scope in New Zealand for digital electronic systems developed locally for the performance of specific jobs; I hope to show that the ideas involved are very simple, and to encourage some of you to enter the field. Having spoken of "digital electronic systems", I had better define them briefly and discuss some basic features. They depend for their operation on variables which have discrete states only. Discrete values lend themselves readily to the operations of binary arithmetic and logical decision.

By discrete variables I mean, for example, such quantities as the position of a uniselector or rotary switch, the stable states of a multi-vibrator, or the states "open or closed" of relay contacts; as opposed to "continuous" variables like complex waveforms.

This is, of course, the story of computers and the systems that I shall proceed to describe are small, special purpose computers developed to perform specific jobs. Common practice in electronic computing is to use electrical quantities with two discrete states, which are readily handled by electronic circuits also with two discrete states:— switching circuits in fact. Such circuits can be made to correspond to schemes of binary arithmetic and logic. Binary arithmetic is normal addition or subtraction but counting in two's instead of tens. Binary logic is the performance of decisions based on the quantities with two states — "go" or "not go". An example of binary logic is a warrant of fitness:— a vehicle will receive a warrant of fitness if and only if, it has "good" brakes (B), windscreen wiper (W), horn (H), steering (S), lights (L) and so on. There is a kind of mathematics — Boolean algebra — in which we can turn such problems as warrants of fitness into symbols, and work on these symbols mathematically. Our warrant of fitness rule becomes:

$$W = B \bullet W \bullet H \bullet S \bullet L \ldots\ldots$$

Continuing our example, a vehicle will NOT receive a warrant of fitness if it has a noisy muffler (N) or dangerous ornaments (O). This we can write as $\overline{W} = N + O$. These are examples of Boolean algebra, in which we have the operations — = NOT, • = AND, and + = OR. The elegant feature of Boolean algebra is that it is directly related to switching or computing circuits. We can design a switching circuit using Boolean algebra, or we can inspect a switching circuit and work out its performance by means of Boolean algebra. This form of mathematics is very simple and easy to use — there are plenty of books on it, and I won't go into further details.

The points to which I have been leading are these:— there exists a simple mathematics for computing and for logical decisions, and it can be performed by electrical or electronic devices: relays, uniselectors, multivibrators, and so on. Circuits used for the performance of computing and logical decisions are "Digital Electronic Systems". With semiconductor devices they yield a high degree of reliability and ease of construction — at P.E.L. we employ first-year trainees on them as a matter of course.

At P.E.L. recent and current work in the digital field includes a high speed digital recording system, a programmed speed control of high accuracy, machine tool control, intervalometers for elapsed time photography and aerial mapping, a programming system for temperature and humidity controllers and a frequency synthesiser. I shall now describe some of these systems, all of which have been made with simple standardised components.

Starting with the intervalometers for elapsed time and aerial photography; these two instruments employ similar circuitry and perform similar jobs. The elapsed time intervalometer is required to trigger an electrically operated camera at precise intervals of from one to one hundred minutes and switch on floodlights before each photograph is taken. The sequence of photographs resulting gives a history of the process or experiment under study. The aerial mapping intervalometer also drives an

This article is adapted from a paper delivered at the 13th New Zealand Science Congress held at Auckland in Feb. 1965.

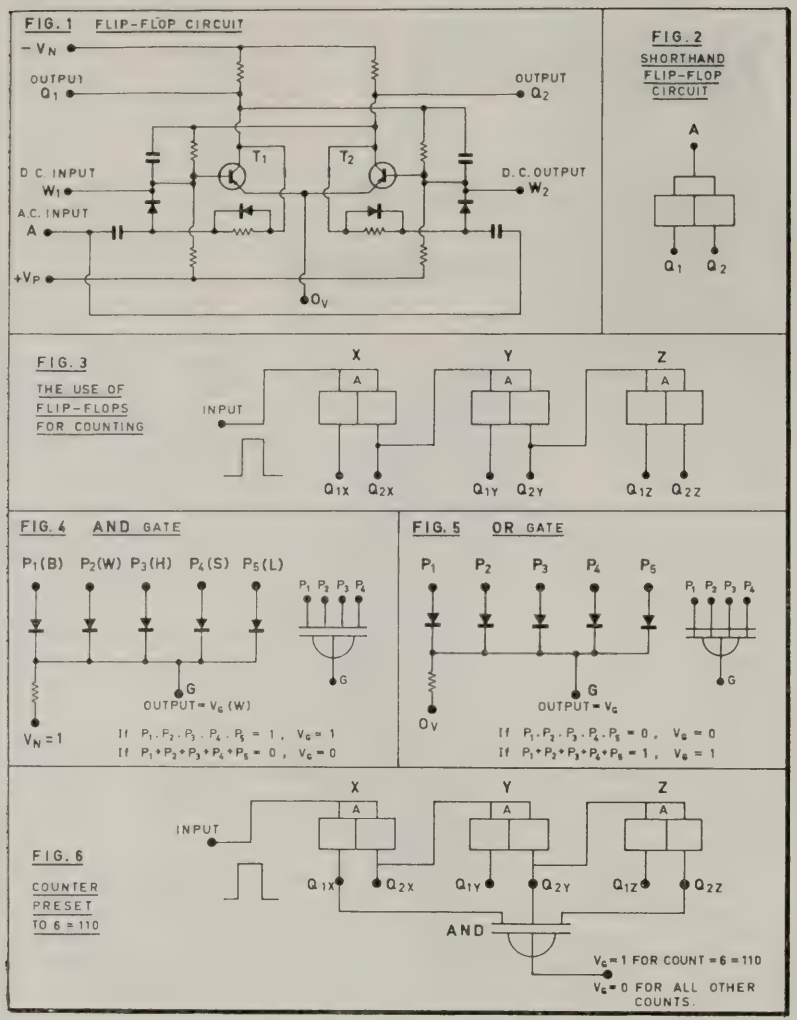


FIG. 1 FLIP-FLOP CIRCUIT
$-V_N$
OUTPUT Q_1
OUTPUT Q_2
T_1
T_2
D.C. INPUT W_1
D.C. OUTPUT W_2
A.C. INPUT A
$+V_P$
O_V
FIG. 2 SHORTHAND FLIP-FLOP CIRCUIT
A
Q_1 Q_2
FIG. 3 THE USE OF FLIP-FLOPS FOR COUNTING
INPUT
X Y Z
A
Q_{1X} Q_{2X} Q_{1Y} Q_{2Y} Q_{1Z} Q_{2Z}
FIG. 4 AND GATE
P_1(B) P_2(W) P_3(H) P_4(S) P_5(L)
P_1 P_2 P_3 P_4
G
OUTPUT = V_c (W)
V_N = 1
If $P_1 . P_2 . P_3 . P_4 . P_5 = 1$, $V_c = 1$
If $P_1 + P_2 + P_3 + P_4 + P_5 = 0$, $V_c = 0$
FIG. 5 OR GATE
P_1 P_2 P_3 P_4 P_5
P_1 P_2 P_3 P_4
G
OUTPUT = V_c
O_V
If $P_1 . P_2 . P_3 . P_4 . P_5 = 0$, $V_c = 0$
If $P_1 + P_2 + P_3 + P_4 + P_5 = 1$, $V_c = 1$
FIG. 6 COUNTER PRESET TO 6 = 110
INPUT
X Y Z
A
Q_{1X} Q_{2X} Q_{1Y} Q_{2Y} Q_{1Z} Q_{2Z}
AND
V_c = 1 FOR COUNT = 6 = 110
V_c = 0 FOR ALL OTHER COUNTS.

At left, illustrations show:
Flip-flop circuit, fig. 1;
Shorthand flip-flop, fig. 2;
Use of flip-flops for counting, fig. 3;
AND gate, fig. 4;
OR gate, fig. 5;
Counter preset to 6 = 110, fig. 6.

electrically operated camera, and is used to generate correct overlap in the sequence of aerial photographs needed for stereoscopic plotting in aerial survey of ground plan and contours.

In the elapsed time intervalometer, pulses are generated at a rate of one per minute by a modified electric clock. These pulses are fed into a counter which can be set so that when a chosen count of value from 1 to 100 is reached, the floodlights are turned on for a short time, in the middle of which the camera is triggered.

With the aerial mapping intervalometer, the operator generates the correct overlap in a sequence of photographs by synchronising a travelling grid with the moving ground image in an optical sight. A given overlap corresponds to a distance travelled by the grid. By means of an optical chopper — lamp and photocell system — there can be generated a fixed number of pulses per unit distance travelled by the grid. These pulses are fed into a preset counter as in the elapsed time intervalometer, and when a preset count is reached, the pilot of the aircraft receives a short warning signal, following which the camera is fired.

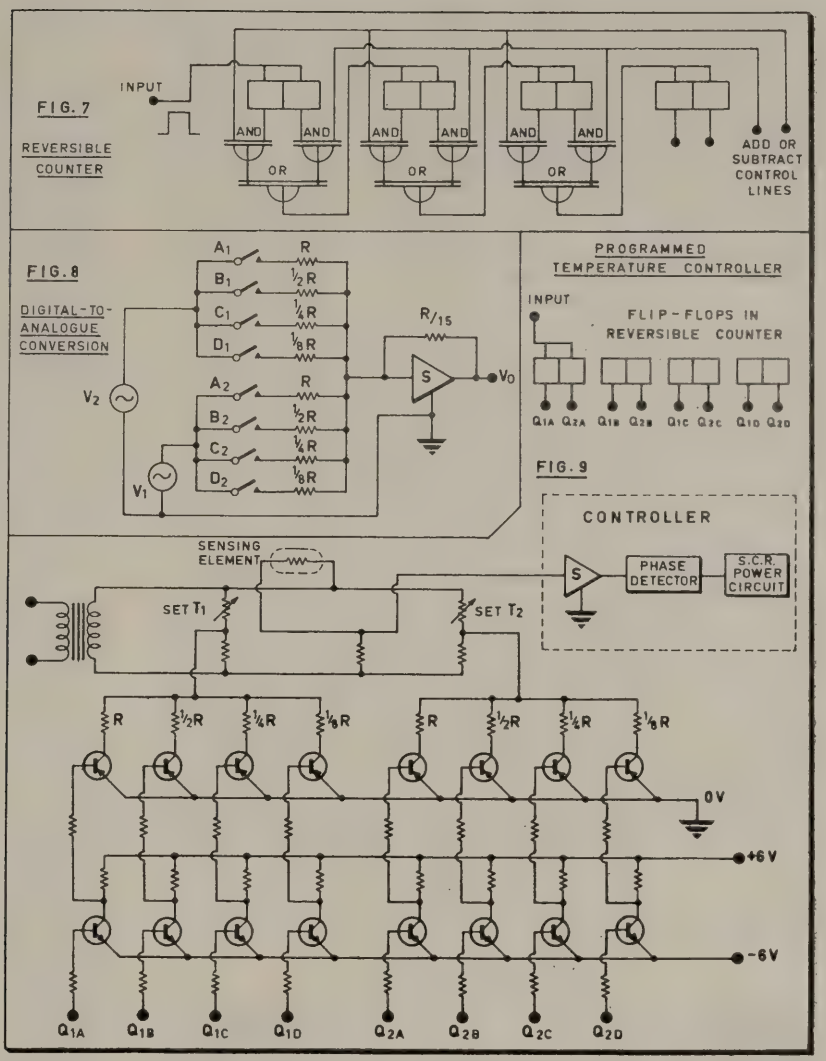
The basic process in the two intervalometers briefly outlined could well be described as "batch counting". A counter registers a series of events, and initiates an action or process when a set number of events have occurred. In our circuits these events are electrical pulses produced as above; they could be produced by anything from tins of paint on a conveyor belt, to sheep jumping into a truck. If you like, the counter could shunt batches of 144 paint tins into packing cases, or when 63 sheep have run down a loading ramp into one truck it could close a gate on them and signal for another truck to drive up and receive 97 sheep.

Preset counters are one form of digital electronic system that show great versatility. Following on our general discussion it is worthwhile to discuss their operation which is a combination of digital arithmetic and logic.

The preset counter is essentially the type of electronic counter, (or scaler) that consists of cascaded flipflops (scales of two), with the addition of an "AND" gate for the recognition of a completed count. I will first explain the flipflop circuit and its use in electronic counting, and then go on to show how a straight counter can be turned into a preset one.

The term flipflop, in this context, refers to a transistor bi-stable multivibrator circuit, commonly

At right, illustrations show:
Reversible counter, fig. 7;
Digital-to-analogue conversion, fig. 8;
Programmed temperature controller, fig. 9



using or resembling the circuit shown in Fig. 1. The flipflop has two stable states, T_1 on and T_2 off, and T_2 on and T_1 off. These states can be shown in a table showing approximate collector voltage.

	Collector T_1	Collector T_2
State 1	V_N	O
State 2	O	V_N

The action of the circuit is that on the A.C. input terminal, only a positive going pulse produces any action in the circuit:— the action being a change from state 1 to state 2, or state 2 to state 1. Let us go now to shorthand notation in which we call O volts O, and V_N volts 1. We can treat a positive going pulse as being a change from 1 to 0, and we can show a flipflop (in "shorthand") as a black box with two output terminals Q_1 Q_2, and an A.C. input terminal A, — see Fig. 2.

Our possible states for the flipflop can now be tabled as:

	Q_1	Q_2
State 1	1	0
State 2	0	1

Suppose now that we take three flipflops X, Y, Z and cascade them as in Fig. 3. The A.C. input A of the flipflop X is driven by a train of positive pulses, and you will see that flipflop Y will change its state whenever there is a positive going change (1 to 0) on the Q_2 terminal of flipflop X, and likewise flipflop Z will change its state whenever there is a 1 to 0 change on the Q_2 terminal of flipflop Y.

We can draw all this up in another table, in which we suppose initially that all the Q_2 terminals are at 0 before we apply the train of positive pulses.

Pulse	Q_2Z	Q_2Y	Q_2X
0 = Initial State	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7 = Counter Full	1	1	1
8 = Original Initial State	0	0	0
9	0	0	1

The table is just a numerical story of what I said above: that a flipflop changes its state for a positive pulse (1 to 0 change) on its input. The flipflop outputs in the table are in reverse order to show their binary counting action.

I'll stop here for a moment and talk about binary

(or scale of-two) numbers. Our normal counting is decimal (or scale of ten). The number 1345 means 1 times a thousand plus 3 times a hundred plus 4 times ten plus 5 times 1: this is to say we have expressed the number in powers of ten. We could equally well use powers of two: try expressing 7 in powers of 2 and you find it is 1 times 4 plus 1 times 2 plus 1 times 1 and we can write it as 111 using scale of two. If you like to work it out, you will find that our example 1345 in decimal is:

10101000001 in binary,

Going back to our table of flipflop states, let us give "weights" of 1 to Q_2X, 2 to Q_2Y, and 4 to Q_2Z. You will see that our table of flipflop states is just a table giving a decimal to binary conversion. So, if you tied an indicator lamp to each output terminal you would be able to read out a count of input pulses as a binary number. To count larger numbers, you merely cascade more flipflops.

So much for the operation of the basic pulse counter employing flipflops. I will now spend some time on the logical operations NOT, AND, and OR, which I mentioned earlier. In my warrant of fitness example of logical decision, I illustrated the idea of "go" or "not go" specification of a quantity. We can use this approach on the output terminal of a flipflop.

We have that $Q_2X = 0$ or 1 — its two possible states.
If $Q_2X = 0$ Q_2X does NOT $= 1$
and if $Q_2X = 1$, Q_2X does NOT $= 0$
We can say NOT $Q_2X = \overline{Q_2X}$ where —— = NOT,
and draw up a table

	Q_2X	$\overline{Q_2X}$
State	0	1
	1	0

You will see two features here:— that $\overline{Q_2X}$ could be obtained from Q_2X by an inverting amplifier, and that this last table simply corresponds to the flipflop output table for Q_1X and Q_2X.

So we have two conclusions:— (1) we can perform the inversion operation NOT with an inverting amplifier, and (2) with a flipflop $\overline{Q_1X} = \overline{Q_2X}$ and $Q_2X = \overline{Q_1X}$.

The operation AND, in our warrant of fitness example was illustrated by $W = B \bullet W \bullet H \bullet S \bullet L$.

If we take $W = 1$ as the issue of a warrant, we have that $W = 1$ if and only if $B = 1$, $W = 1$, $H = 1$, $S = 1$, $L = 1$. The AND gate to perform this relation is shown in Fig. 4. In the same figure we show a symbol for such a gate. The OR gate is shown in Fig. 5. You will note incidentally, that an AND gate for 1 states, is an OR gate for 0 states, and conversely.

We can now complete the story of the preset counter. Consider our simple 3 stage counter and its table of counts, and suppose we wish to preset it to the number 6 (decimal) = 110 (binary). We note that in this number $Q_2X = 0$, $\overline{Q_2Y} = 1$, $Q_2Z = 1$, and we can also say $Q_1X = \overline{Q_2X} = 1$, $Q_1Y = 1$, $Q_2Z = 1$.

To preset the counter so that it gives a signal on completion of count 6, we connect a three pole AND gate to the output terminals Q_1X, Q_2Y, Q_2Z as shown in Fig. 6. There will be a 1 signal from the AND gate if and only if there is a count of 6 in the counter. If necessary, we can use this 0 to 1 signal from the AND gate to reset the counter to zero on completion of the count. We have in fact done this with all our preset counters so far, although there could be applications where the reset action is not wanted.

If one is interested in precise frequency division by large numbers, prime or otherwise, the preset counter makes a very versatile frequency divider, as we found in the development of a frequency synthesiser working in the range 10 to 30 kilocycles per second with frequencies available in steps of 100 cycles per second over that range. An extension of the preset counter is the end-stopped reversible counter. This has been used successfully in a digital speed control system, and its application to the programming of temperature and humidity controllers looks very promising. I've discussed the working of a straight binary counter in which one output of each flipflop is connected to the input of the following flipflop. A binary number of input pulses applied to the input of the counter can be read off the line of flipflop outputs as shown earlier. Now, suppose that we read the counter from the same output terminals as before, but connect the input terminals of the flipflops to the alternate output terminals. We find that the application of a train of pulses at the input causes the counter to count (according to our readout terminals) in reverse, or subtract. We can make our counter either subtract or add by interchanging the flipflop input connections. In practice, we perform this with gates, in which we apply 0 or 1 levels to the control terminals to govern whether we add or subtract. See Fig. 7. By applying combinations of 1 and 0 levels to both add and subtract control terminals we can stop further add counts if the counter becomes full in the add direction, or if we wanted we could stop both add and subtract counting altogether when the counter became full on either add or subtract.

The reversible end-stopped counter can be used to programme controllers and servo systems. One particular interest in studying this line is the programming of temperature and humidity controllers; the idea is a general one, however, which could be applied to any system working on continuously variable voltages; I will discuss the way in which it can be applied to a controller working from an A.C. bridge such as a humidity or temperature controller.

I have described how to make the counter reversible; the addition of end-stopping merely means that it is preset at two states:— a state in which all the Q_1's are in the 1 state, and the state in which all the Q_2's are in the 1 state. Each of these states can be sensed by AND gates, and if we call these states "Add full" and "subtract full" we can arrange that when the "add full" gate gives a 1 signal we stop further "add pulses" and when the "subtract

full'' gate gives a 1 signal we stop further ''subtract pulses''.

So far so good — we now have a reversible counter which can be made to add or subtract, and stop when it is full, rather than go round the clock. We can let each of the flipflop outputs in the reversible counter control a switch — we can do this by driving a transistor from each flipflop output, and using its collector and emitter terminals as the poles of a switch. For low level A.C., general purpose transistors can make excellent switches, provided that the base current turning the transistor ON is greater than the peak current switched and that the reverse base-emitter voltage turning the transistor OFF is greater than the peak voltage to be switched. Consider now the circuit shown in Fig. 8. We have two voltage generators V_1 and V_2 feeding a summing amplifier S through resistors R, R/2, R/4, R/8 controlled by switches A_1, B_1, C_1, D_1, and A_2, B_2, C_2, D_2. Let us suppose that if when switch A_1 is open then A_2 is closed, and vice versa. We can call the closed state of a switch 1 and the open state 0. Then we can draw up a table

A_1	A_2
1	0
0	1

and we can state in our symbolic terms that $A_1 = \overline{A_2}$, similarly, let $B_1 = \overline{B_2}$, $C_1 = \overline{C_2}$, $D_1 = \overline{D_2}$.
Now, suppose $A_1 = B_1 = C_1 = D_1 = 1$ (i.e., all closed) for which of course $A_2 = B_2 = C_2 = D_2 = 0$ (i.e., all open) then the parallel resistors will define an input current to the amplifier of $15V_1/R$, resulting in an output voltage from the amplifier of $V_0 = V_1$. For the opposite configuration $A_2 = B_2 = C_2 = D_2 = 1$ we get $V_0 = V_2$.

Now, suppose we operate the switches systematically as shown below — you will see that the switches correspond to binary digits — and enter the values of V_0 at the right of the switching table.

Count	A_1	A_2	B_1	B_2	C_1	C_2	D_1	D_2	V_0
0	0	1	0	1	0	1	0	1	V_1
1	1	0	0	1	0	1	0	1	$\frac{14V_1}{15} + \frac{1V_2}{15}$
2	0	1	1	0	0	1	0	1	$\frac{13V_1}{15} + \frac{2V_2}{15}$
7	1	0	1	0	1	0	0	1	$\frac{8V_1}{15} + \frac{7V_2}{15}$
8	0	1	0	1	0	1	1	0	$\frac{7V_1}{15} + \frac{8V_2}{15}$
14	0	1	1	0	1	0	1	0	$\frac{V_1}{15} + \frac{14V_2}{15}$
15	1	0	1	0	1	0	1	0	V_2

Clearly V_0 progresses in steps from V_1, to V_2. The states of the switches correspond to the states of a four bit counter, so that if we use a reversible counter to control the switches we can go back and forth between the two set voltages V_1 and V_2, settling on any value we choose. This is an example of Digital-to-Analogue conversion. An example is shown in Fig. 9 which shows the programming of a bridge (for temperature or humidity control) between two extreme values set by two bridge arms. We are working this system for the programming of temperature and humidity controllers; it could be applied to servo systems, or a self-balancing bridge with digital readout, to mention possible applications.

At this stage, some of you are bound to say, ''These control systems are all very fine, but who is going to wire up the hundreds of transistors? What about the cost? Why not use mechanical devices?'' Agreed, digital control systems do use hundreds of transistors, but circuits can be purchased ready made, as building blocks turned out by such firms as Philips, Mullard, and Ferranti. There is full information available telling you how and where to use them. As for cost, you can't afford not to spend money where good and versatile equipment is needed. Mechanical devices — you don't hear of them being sent up in rockets — and they have neither the versatility nor the reliability of good semiconductor electronics.

To conclude, I have tried to show how in the field of digital electronics simple ideas can be used to develop versatile equipment. Digital electronics is an expanding field which I hope some of you will enter in the near future.

ENQUIRY CARD AD. 11

FIG. 1

Fig. 1 Make up of square wave from harmonics.

Simple Testing Of Audio Equipment Using Square Waves

In the design of, say, pre-amplifiers it is convenient to be able to decide quickly how compensation, boost or cut circuits are acting in a qualitative way without going through tedious frequency response runs with an oscillator and V.T.V.M.

With a fully equipped laboratory it is possible to do quick runs with either a high speed chart recorder or the cathode ray oscilloscope type of audio frequency response curve tracer for visual display. However, neither of these equipments will be found close to hand when the home experimenter wishes to run a quick check on an amplifier under construction.

In this short article we describe what tests are needed on an amplifier and how much of the information given in detail by more expensive methods can be compressed into one measurement, albeit with less accuracy, provided a cathode ray oscilloscope is owned.

Some usual audio amplifier tests

A. Frequency range:— audio oscillator plus V.T.V.M.

B. Tone controls etc.:— audio oscillator plus V.T.V.M.

C. Stability, transients etc:— Square wave plus CRO.

D. Gain:— audio oscillator plus V.T.V.M.

E. Power output:— audio oscillator plus V.T.V.M. (and hum) (CRO optional).

To measure, quantitively, harmonic distortion and intermodulation distortion, special distortion measuring meters are required. However, distortion over 5% or 7% can start to be seen on a C.R.O. trace, providing the audio oscillator has good wave form to begin with.

Tests A to E require plotting many measurements that may not be needed if only a rough check or indication is required. What is needed is a signal source containing a range of frequencies in one "bundle". Such can be found in a square wave and also in white noise.

Square Waves

Mathematical analysis of square waves, by Fourier's method, shows that a regular square wave of amplitude A comprises the components

$$F + (3F \times A/3) + (5F \times A/5) + (7F \times A/7)$$
etc.

Where F is the fundamental repetition frequency. This can be shown as in figure 1 where even a small number of harmonics tend to a square wave. Study of figure 1 will show that the absence of the earlier harmonics, say, 3rd 5th or 7th, or diminished value of them, will alter the shape of the square wave. The attenuation of any part of the square wave due to "absorption" of its components by failings in the amplifier will thus be shown on a cathode ray oscillogram of an amplifier output.

In addition to attenuation, or accentuation, of components the change of phase with respect to frequency can also be seen. In figure 1 all the harmonics are in phase with the fundamental. Any phase displacement of a harmonic (or fundamental) due to transit through an amplifier will also show up in the output oscillogram. Thus, an additional test, not listed in A to E, can also be checked.

Choice of Test Frequencies

Practical experience with square wave testing over a number of years by various authorities in the audio field indicates that a square wave will provide useful information about amplifier performance up to the 10th harmonic of the square wave. Thus it is usual to provide three fixed frequencies for general purpose work —

20c/s
200c/s
and 2Kc/s

and variable frequencies are more of a hindrance than a help in routine testing. Also, unity mark to space ratio is all that is necessary i.e. the "on-off" periods are equal.

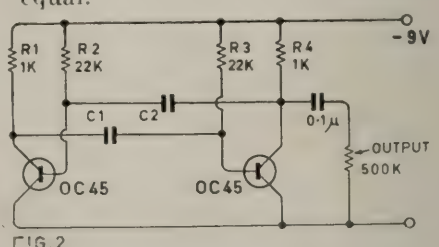


FIG. 2

Fig. 2 Circuit of simple square wave generator. C1 and C2 values:—

for 20 c/s	repetition rate	.0125 μF.
200 c/s	,, ,,	.125 μF.
2000 c/s	,, ,,	1.25 μF.

These values are "centre" ones and slight variations may be needed for exact chosen frequencies.

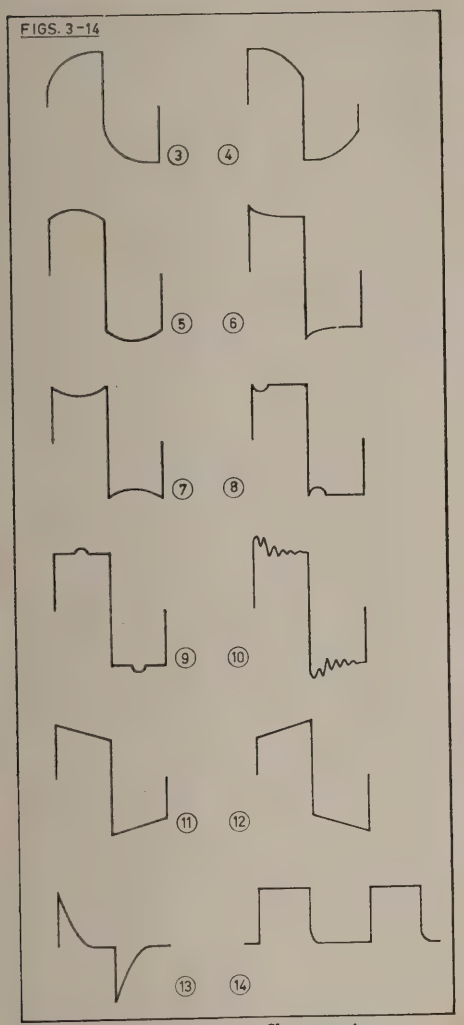


Fig. 3 Poor high frequency response.
Fig. 4 Poor low frequency response.
Fig. 5 Emphasis at low frequencies.
Fig. 6 Emphasis at high frequencies.
Fig. 7 Poor response at fundamental (square wave) frequency.
Fig. 8 Drop in gain at one particular band.
Fig. 9 Emphasis of one particular band.
Fig. 10 Singing.
Fig. 11 Phase shift leads at low frequencies.
Fig. 12 Phase shift lags at low frequencies.
Fig. 13 Coupling capacity too low, producing differentiation.
Fig. 14 Waveform of square wave generator showing sounding.

The Square Wave Generator

Transistor techniques have been chosen so a cheap, small and light weight unit can be built.

A simple two transistor astable multivibrator circuit is shown in figure 2. OC71 transistors have been chosen as being cheap and having sufficiently high switching times for the low repetition rates involved.

As fixed frequencies are used capacitors C1 and C2 are switched only. R2 and R3 could be ganged and varied if continuously adjustable control is required.

Disproportionate mark-space ratios can be obtained by unequal values of C1R2 and C2R3 but these are no advantage in a simple instrument.

The values of C1 and C2 as shown are only approximate but exact values could be chosen by frequency comparison methods on a C.R.O.

Interpretation of results

Figures 3 to 13 show the types of output wave shapes to expect for the faults indicated.

More generally, the situation can be stated as:—

1. If the flat top is tilted, but straight, there is phase shift.

2.If the leading edge is rounded there is poor high frequency response.

3. If the trailing edge is rounded there is poor low frequency response.

4. If there is very sharp trailing edge fall away coupling capacities may be too low causing differentiation of the square wave as in figure 13.

It is worthwhile to spend some time with pencil and paper reasoning out why the various output shapes occur because to do so will make the wave shapes far easier to remember for reference purposes.

Final notes of caution

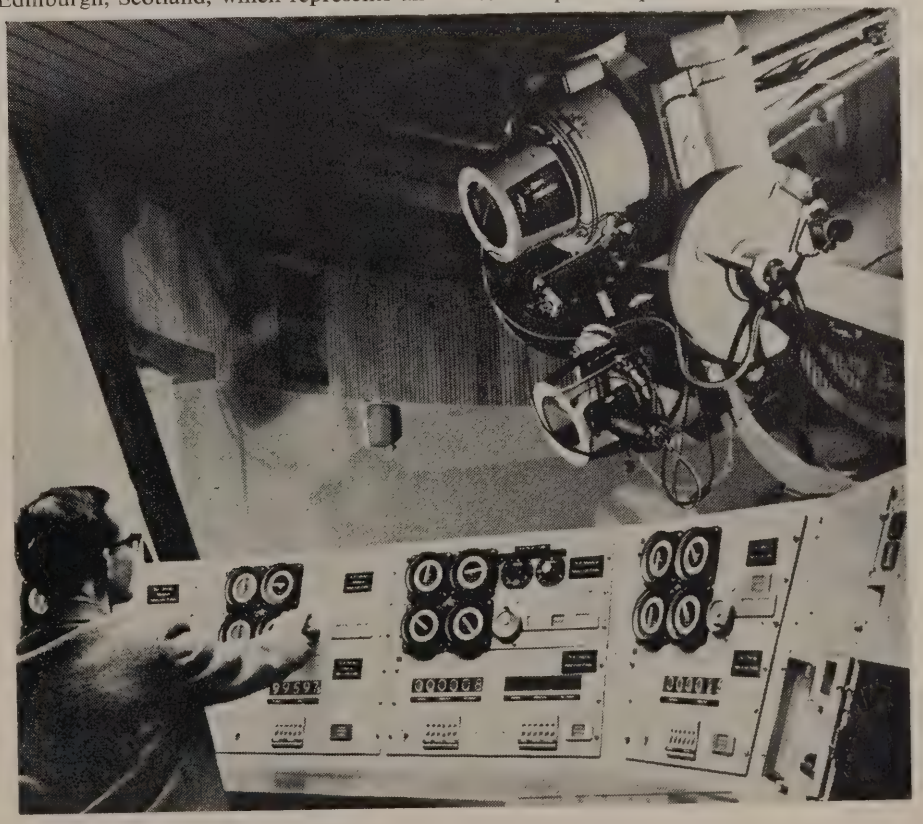
Although the leading edge of the square wave and the top are clean the foot of the trailing edge is slightly rounded as shown in figure 14. Such an effect should be allowed for in viewing the resultant output. This slight fault is the price paid for such a simple generator.

So as to avoid differentiation of the output ensure that the load impedance is as high as possible — certainly at least 500K ohms. The output voltage approaches the supply voltage so plenty of output is available so a low tap on the 500K potentiometer will be possible. Lower supply voltages still provide good square waves but the rounding shown in figure 14 becomes more pronounced.

ADVANCE IN TELESCOPE AUTOMATION

Automatic control by simple dial setting has replaced lengthy manual operation on the new automatic twin 16-inch telescope at the Royal Observatory, Edinburgh, Scotland, which represents an important advance in the automation of telescopes.

Automation permits the telescope to be operated by a single person with all measurements recorded directly on to computer tape.



CHEAPER POWER IS POSSIBLE BY WAY OF M.H.D.

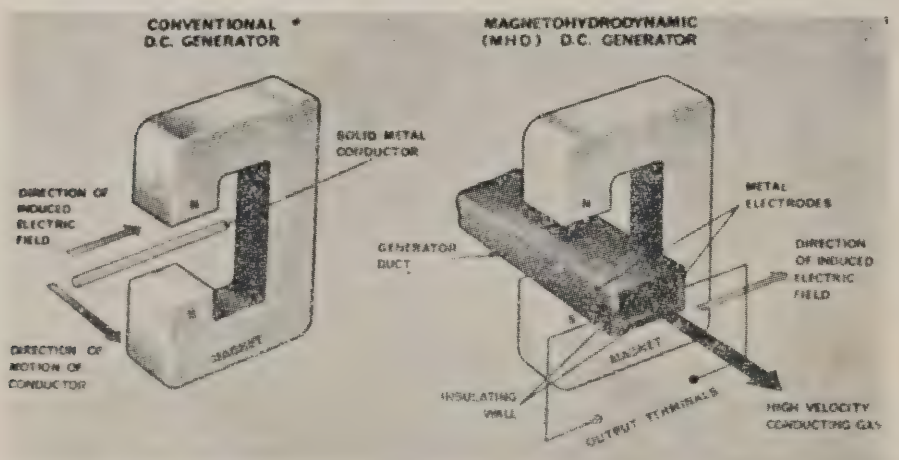
By JOHN NEWELL

These days, the designers of both nuclear and conventionally powered generating stations are becoming interested in a new means of making electricity. The method is called magneto-hydro-dynamic (MHD) power generation —or sometimes magneto-plasma-dynamic (MPD)—and in spite of its complicated name it is really simpler than the conventional way of making power.

A coal, oil or nuclear furnace can be used as its source of heat.

A power station, nuclear or conventional, works by boiling water, to make steam, to drive a turbine, which spins a coil of copper wire between the poles of a magnet.

As the copper wire cuts across the lines of magnetic force, an electric current is automatically produced in the wire. Copper wire is an extremely good conductor which is easy to handle and relatively cheap but, in fact, if any conductor of electricity is moved across lines of magnetic force, then a current is started within it.



In MHD the conductor is a jet of hot gas. Instead of a coil being spun between the poles of a magnet the jet is shot between them. The current which is set up in the gas is picked up by means of electrodes placed on either side of the gas stream.

The great advantage of MHD over conventional power generation is that it cuts out complications that waste energy in producing electricity. Gas can be taken straight from the furnace and passed between the poles of the magnet to make electricity, instead of being used to boil water to make steam to drive a turbine. The gas used can be either the exhaust gas from a coal or oil furnace or perhaps the inert gas used to cool a nuclear reactor. However, the disadvantage is that either kind of gas conducts electricity far less efficiently than copper wire does. So a correspondingly greater magnetic field is required to deliver an equivalent amount of power.

Still, there are two ways of making the gas conduct more electricity and so raising the efficiency of an MHD generator. One is to raise the temperature of the gas, which also raises its conductivity. The other is to "seed" the gas with a substance which itself helps to conduct electricity and also assists gas molescules to split up into charged particles, which then conduct electricity more easily.

In 1964, Britain's Central Electricity Generating Board (CEGB) announced that it was developing what is called an "open cycle" MHD system. This is an experimental generator in which the gases from a coal or oil furnace are led away and accelerated between the poles of a magnet, the current being picked up from electrodes placed on either side of the duct beyond the magnet. This system, one of the world's more ambitious, is called open cycle because the exhaust gases from the furnace are allowed to escape once they have been used.

The International Research and Development Company (IRD), at Newcastle-upon-Tyne, is developing the alternative kind of MHD. This is the "closed cycle" system, in which the same gas is used over and over again to make power. In theory, the closed cycle system is best suited to making MHD power from a nuclear reactor. This is because helium, which is one of the gases used to remove heat from reactors, can be easily re-cycled.

There are obvious economies in using the same gas over and over again. Not least is the fact that the expensive seed material can also be used over and over again. But the snag here is that it has so far been impossible to raise the temperature of helium from a nuclear reactor high enough to conduct a useful amount of electricity.

At the moment there is a big gap between the highest temperature to which a nuclear reactor can raise helium and the minimum temperature at which helium can be persuaded to conduct a reasonable amount of electricity. The experimental Dragon reactor, built in England by twelve European nations including Britain, at Winfrith Heath in Dorset, uses specially-designed elements to heat helium gas up to around 750 degrees Centigrade.

Until early in 1964 it was believed that the lowest temperature at which helium could conduct sufficient electricity to make MHD economical was 1500 degrees Centigrade. Then IRD announced that they had succeeded in lowering that temperature to around 1200 degrees Centigrade by using a special seed and a new design of the gas duct past the magnet. The "temperature gap" which nuclear scientists and engineers all over the world are now trying to bridge, was reduced from 750 to 450 degrees.

This still leaves a long way to go, but promising attempts are also being made to try to bridge the gap from the other end. To produce a helium temperature of 750 degrees the actual fuel core of Dragon was allowed to heat up to 1500 degrees. This proved so successful, and so easily within the bounds of the reactor's abilities, that the international team of scientists at Winfrith are now running the reactor up higher still to 2000 degrees. This will raise the helium temperature at least a further 100 degrees, and cut the gap down to around 350 degrees.

ENQUIRY CARD AD. 13

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We specialize in this field and manufacture a full range of interference suppressor inductors for use both internally and externally on equipment.
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AWA HIGH FIDELITY AM TUNER

Circuit and Service Data

DESCRIPTION

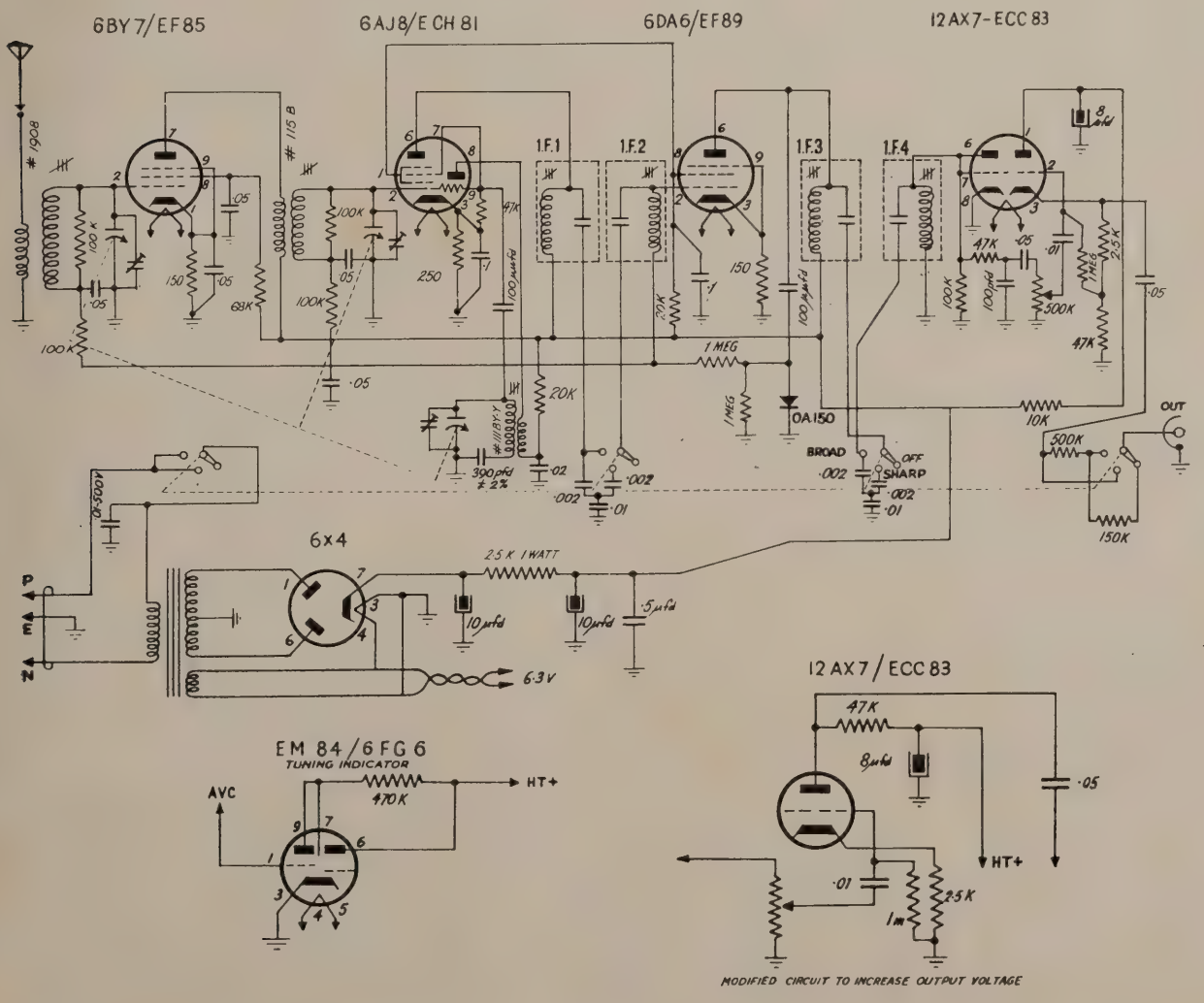
The A.W.A. Mk. II Tuner is designed to provide the best possible results from AM Broadcast Band Transmissions. The circuit employs an RF Stage, the coils of which are damped to provide a wide pass band. The IF Stage uses "Bottom Coupled" IF coils to provide two degrees of selectivity, the second detector stage is fed into a Cathode Follower which enables long output cables to be used without impairing the High Frequency response.

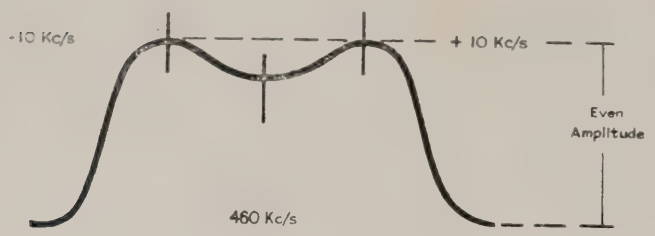
TESTING PROCEDURE AND ALIGNMENT

IF Alignment

Set generator to 460 Kc/s and with selector switch in sharp position, align IF's in normal manner for precise peak.

Switch to broad position and check displaced peaks by swinging generator, peaks should be 10 Kc/s displaced from centre for even amplitude; if necessary, make slight adjustment to IF.1 and IF.3 to satisfy this condition.





RF Alignment

1. Selector switch in sharp position.
2. Set pointer to 1,400 Kc/s and align mixer and RF Trimmer for maximum output.
3. Set pointer to 600 Kc/s and adjust antenna and interstage coil slugs for maximum output.

TECHNICAL SPECIFICATIONS

Frequency Response:

Overall Frequency Response 100,000 micro-volts input at 1 megacycle.
Flat from 20 cycles to 7,500 cycle.
Minus 2 db at 10,000 cycles.
Minus 20 db at 15,000 cycles.
(Broad position).

Distortion:

Overall Distortion (400 cps.).
.4% at 30% modulation.
3.5% at 80% modulation.
4.75% at 100% modulation.

Output Voltage with Input 100,000 Microvolts:

Audio Output Voltage measured at Tuner output socket (400 cps.).
.07 Volts with 30% modulation.
.27 Volts with 100% modulation.

Sensitivity:

Sensitivity for 12 db (4 to 1) signal to noise ratio modulation on/off—

1,400 K/c	20 Microvolts.
1,000 K/c	14 Microvolts.
600 K/c	7 Microvolts.

Tube Complement:

One 6BY7 (EF.85) — R.F. Amplifier.
One 6AJ8 (ECH.81) — Converter.
One 6DA6 (EF.89) — IF Amplifier.
One 12AX7 (ECC.83) — Demodulator and Cathode Follower Output.
One OA.150 — Germanium Diode, AVC Rectifier.
One 6X4 — Rectifier.
One EM84/6FG6 — Tuning Indicator.

Power Requirements:

20 watts.

Dimensions:

Length 13⅜ inches. Depth 6½ inches. Height 3⅞ inches

AWA RADIOLA RADIO

Model PZ22

Circuit and Service Data

ALIGNMENT INSTRUCTIONS

1. Equipment required:—
   (a) A signal generator to cover 450Kc/s to 1500Kc/s, modulated 30% at 400 or 1000 c.p.s.
   (b) An output wattmeter with a range of 0-2.0W to match 25 ohms impedance.
   (c) A non metallic trimming tool suitable for adjusting the I.F.T. and oscillator coil cores.
   (d) A 10 p.f. capacitor for injecting signals into the tuned aerial circuit and a 6.8K resistor for desensitizing the receiver during R.F. alignment.
2. The signal generator should be switched on at least 15 minutes before beginning alignment.
3. Set the receiver volume control to maximum. During the alignment, the signal input should be adjusted to maintain the output at 500mW each time a trimming adjustment is made. The tone control should be set to maximum treble response.

Audio Circuit

1. If the output pair of transistors (117's) are replaced, readjust the quiescent battery current to 23m.A., under no signal and minimum volume conditions, with RV3.
2. Audio sensitivity should be better than 500mW for 20mV to the top of the volume control at 1.0Kc/s.
3. Audio output should be greater than 2.5 watts into 25 ohms.
4. At 1.0w output total current drain should be 300mA ± 20 mA.

I.F. Alignment

1. Set signal generator to 455Kc/s and receiver to low frequency end of band. Inject the I.F. signal into the base of the converter.
2. Tune 3rd I.F.T. to peak nearest circuit board.
3. Tune primary and secondary of 2nd I.F.T. to outer peaks.
4. Screw the primary (lower) core of the 1st I.F.T. right out. Tune the secondary (upper) core to the outer peak and then peak the primary winding on the outer peak. **Do not** readjust secondary.

R.F. Alignment

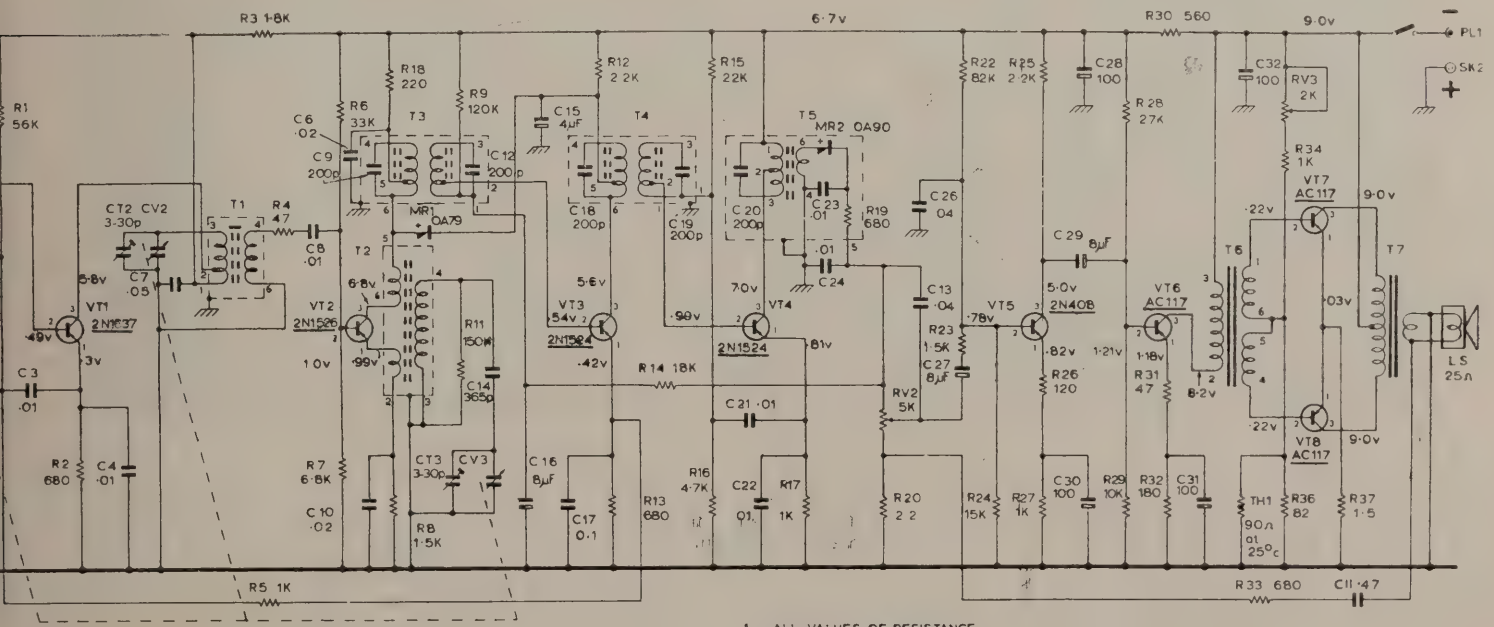
Temporarily disensitize the receiver by connecting a 6.8K ohms resistor between the junction of R14 and C16 to chassis.

Connect signal generator via a 10 p.f. capacitor to the tap on the tuned aerial coil winding.

1. Check that when the gang is fully meshed, the pointer lines up with the edge of the light track at the low frequency end of the scale.
2. Adjust the oscillator coil (T2) core at 600Kc/s and oscillator trimmer (CT3) at 1500Kc/s for max. response.
3. Adjust the R.F. transformer (T1) core at 600 Kc/s and R.F. and aerial trimmers (CT2 and CT1) at 1500Kc/s for max.
4. The ferrite rod is unlikely to require adjustment, but, if necessary the coils L1 and L2 should be moved along the ferrite rod for maximum output at 600Kc/s and then re-sealed with wax.
5. Check alignment at 1000Kc/s.

D.C. Resistances

T1	R.F. Coil	1-2	0.6 ohms
		1-3	4.9 „
		4-6	0.5 „
T2	Osc. Coil	1-2	0.2 „
		3-4	3.3 „
		5-6	0.4 „
T3, T4	1st & 2nd I.F.	1-2	0.5 „
		1-3	9.0 „
		6-5	3.4 „
		6-4	9.0 „
T5	3rd I.F.	3-2	6.1 „
		3-1	9.6 „
		4-6	1.7 „
T6	Driver Transformer	2-3	160 „
		1-6	68 „
		4-5	68 „
T7	Output „	Pri. each half	0.9 „
		Sec.	1.5 „



1. ALL VALUES OF RESISTANCE IN OHMS & ALL VALUES OF CAPACITANCE IN MICRO-FARADS UNLESS OTHERWISE STATED.
2. VOLTAGES STATED ARE NEGATIVE WITH RESPECT TO CHASSIS & MEASURED WITH AVO NO.8 UNDER NO SIGNAL CONDITIONS & WITH VOLUME CONTROL SET TO ZERO.

ENQUIRY CARD AD. 15

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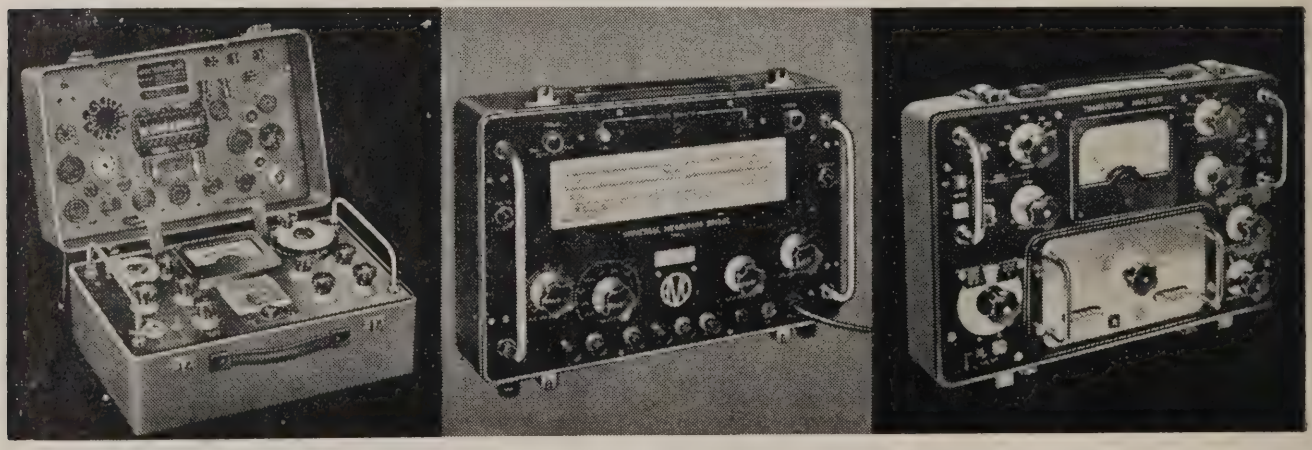
NEECO

Avo electronic testmeter
A 56 range valve voltmeter for the electronic engineer capable of making a very wide range of measurements not normally covered by this type of instrument. The measuring circuits employ very high input resistances even when low voltage ranges are in use.

Avo Electronic Multimeter
This 95 range instrument consists basically of a highly stable balanced valve d.c. millivoltmeter with a full scale sensitivity of 250 mV, a radio frequency diode head, a decade radio-frequency amplifier, voltage multipliers, shunts, wattage load circuits and a valve stabilised power supply.

Avo valve characteristic meter, Mk. IV
A most comprehensive bench type Valve Tester which will test most standard receiving and small power transmitting valves on any of their normal characteristics under conditions corresponding to any desired set of d.c. electrode voltages.



Avo valve Tester, Type 160
This portable instrument will check most standard receiving or small transmitting valves and will produce accurate readings of mutual conductance. It can be easily operated by an unskilled person.

There is also a full range of AVO Measuring and Precision Instruments.

Avo universal measuring bridge, Type 1
A self-contained mains driven model, this instrument has 24 calibrated ranges for the measurement of resistance, capacitance and induction.

Avo transistor analyser
A portable or mains instrument for measuring transistor parameters in the grounded emitter configuration. *Ranges:* Current: 0-100 uA, 0-1mA, 0-10mA, 0-100mA, 0-1A. Voltage: 0-1.5v, 0-15v, 0-150v, with a sensitivity of 20k ohms. The movement is protected against damage by overloads.

A1.4

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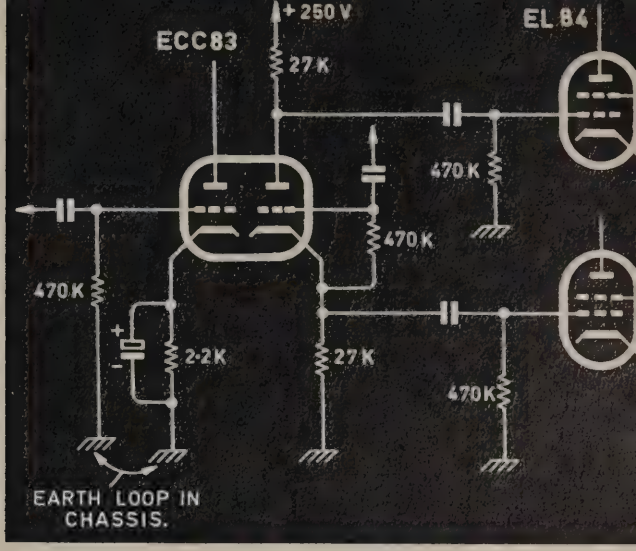


SERVICEMAN'S COLUMN

Conducted by

J. Whitley Stokes

Included this month you will find a dissertation on hi-fi amplifiers by T.C.K. In the course of it he makes a plea against ill-considered modifications to commercially produced equipment. In this respect I must heartily concur, always assuming that the original design is beyond reproach, that is.

Unfortunately even in these enlightened days it is not always possible to take this for granted. So partly by way of a contrast and partly because I feel rather strongly about the matter I am going to speak out against the poor design and construction of a locally produced P.A. type amplifier, or rather two of them.

Examine then if you will, the accompanying diagram of the circuit of the phase splitter and output section of one of these amplifiers, and see if you agree with my criticisms.

The first and most obvious fault is that the phase splitter is running without any bias.

Secondly even with bias, the value of the plate and cathode load resistors do not fall within the limits of the recommended operating condition published by any valve manufacturer. Remember the valve is a high μ triode with a plate resistance of between 60K and 80KΩ. Even at the minimum permissable value (47KΩ) of load resistor with 250 volt supply the total harmonic distortion is 7% at full output, and in this case the load was only 27K. One gets the impression that the load resistors have been reduced to such a low value in an attempt to secure a higher plate voltage under the conditions of excessive plate current brought about by the lack of bias.

Thirdly there was a steady and very noticeable hum caused by the presence of an earth loop between the grid return of the 3rd stage and its own cathode earth point.

Lastly the omission of stopper-resistors on the EL84 output valve grids is surely inexcusable when such valves boast a mutual conductance of 11.3mA/V. Without grid stoppers there is the ever likely possibility of their "taking off" at the slightest provocation.

All in all a poor show but worse is to follow. At least in the above case none of the above "blues" caused the amplifier to be inoperable whereas in the second case a new amplifier proved to be virtually unusuable solely due to poor design, as distinct from any factory fault.

The amplifier in question was installed in what can best be described as a mission hall and shared a place of honour with a tape recorder and an electric or rather electronic organ. Wondrous are the uses of electronics — even unto the salvation of mankind!

When first installed the amplifier proved to have a most frightful hiss coupled with an equally objectionable hum which could be heard all over the hall. In addition the volume control was almost unusuable due to its effective range being restricted to the first few degrees of rotation. This was so bad that the first notch corresponded to almost "full bore" As the hiss and hum were apparent with the volume control at zero it seemed likely that there was too much gain after the volume control, and judging by the behaviour of the volume control just too much gain, period. Furthermore the darned thing picked up every stray click, pop and crackle imaginable together with the odd VHF mobile service thrown it. It was not even possible to run the organ at the same time without it interfering with the amplifier. What could be done ?

An examination of the valve line-up confirmed the suspicion that the overall gain was excessive as there were three halves of ECC 83's in cascade the last one being a high gain phase inverter fading push pull EL84's. As an emergency operation the last two ECC83's were replaced with ECC82's which resulted in a considerable improvement and allowed the use of the amplifier until it could be spared for a more complete investigation. Without going into too much detail it is sufficient to say that I eventually left the two ECC82's in position after altering the plate load resistors accordingly. It was also necessary to shield some long unshielded grid leads running to the tone and volume controls, in fact there wasn't an inch of shielded grid wire anywhere originally.

Well so much for that, and I can only say I find it surprising that such poorly designed articles can get on to the market. I'm afraid I don't know of any effective way of preventing it either. Possibly the suggestion put forward in the March editorial:— "What is needed is an association within the industry concerned with ethical and technical matters and not with Dealer's Associations", would be a step in the right direction.

\+ + +

From time to time imported amplifiers still find their way on to the service bench. I have now had several calls to service the "Linear Diatonic" so suppose there are other readers in a similar situation.

Continued on page 37

LISTENING POST

by michael lawrence

SUNSPOT ACTIVITY

Since the sunspot minimum, about a year ago, there has been a gradual, but somewhat erratic, increase in the sunspot numbers reported from Zurich. The average monthly sunspot number has increased from 4.5, around September and October of 1964, to a maximum of 26.4 during May 1965 — the daily maximum during this month was actually 82 — however, this figure has dropped back and the latest available data, which is for July, gives an average for the month of 11.9. Predictions indicate that for the remainder of the year, the average should range from 20—30.

The result of this increase in sunspot numbers will be a corresponding increase in the maximum useable frequency in the shortwave bands, which will allow many more stations to operate in the higher bands above 15 Mc/s. However, at the present time, it is too early to expect the increased sunspot number to have any effect.

It is interesting to note the method used for obtaining the sunspot numbers.

Solar observations are made at many astronomical observatories around the world, and the information published in the form of "relative sunspot numbers". This is arrived at from the formula: $k(f + 10g)$, where g is the number of sunspot groups and f is the number of spots within these groups. The factor k allows for the variations between telescopes and observers. The observations from the different observatories are correlated with that at Zurich and the final "number" published from there.

Details of solar activity are continuous as far back as 1750.

Sunspot numbers for the previous month are broadcast by the Swiss Broadcasting Corporation in all transmissions of "Swiss Shortwave Merry-go-round" on the first Saturday after the 3rd of the month.

STATION NEWS

All frequencies are given in kilocycles and times in GMT.

PAKISTAN. Radio Pakistan can be heard at good strength at 1500 on 9,820.

GHANA. The External Service of the Ghana Radio and Television Corporation broadcasts in English as follows:—

Monday, Wednesday and Friday: 0300 - 0345 on 6,070; 1500 - 1545 on 21,720.

Tuesday, Thursday and Saturday: 0430 - 0515, 0600 - 0645 and 2000 - 2100 on 9,760; 1645 - 1730 and 1815 - 1900 on 15,285.

AUSTRALIA. The only changes in the latest English schedule of Radio Australia are in the transmission to South and South East Asia where 9,570 is now on from 0830 - 1730 and in the South Pacific transmission where the closing time of 9,570 has been changed from 0915 to 0815.

FRANCE. Good signals are received from Radiodiffusion — Television Francaise on 6,175 and 9,560 at 0600 when the programme is in French for 45 minutes.

NORWAY. The schedule of Radio Norway effective from 5th September is:— 0300 - 0430 11,850 9,610 6,185; 0745 - 0815 17,825 15,175 11,850; 1100 - 1230 17,875 15,175 11,850; 1300 - 1430 17,825 15,175 11,850; 1500 - 1630 17,825 15,175 11,850; 1700 - 1830 17,825 15,175 11,850; 1900 - 2030 17,825 15,175 11,850; 2300 - 0030 11,850 9,610 6,185; 2100 - 2230 11,850 9,610 6,185.

"Norway this Week", a programme for English speaking listeners is broadcast every second hour from 1200 to 2000 on Sundays and repeated at 0000 and 0400.

The Norwegian Home Service is carried on 11,735 with a transmitter power of 10 kW.

IRAQ. Radio Baghdad broadcasts in English from 1930 - 2000 on 6,030 and 6,095.

TURKEY. The Voice of Turkey at Ankara uses the frequency of 15,160 for a transmission in Turkish from 2145 - 2200 and in English from 2200 - 2230.

HUNGARY. English transmissions from Radio Budapest are broadcast as follows:—

To Europe: 1930 - 2000 and 2200 - 2230 on 9,833 and 7,305 with 7,215 and 6,234 being additional frequencies for the second transmission.

To North America: 0030 - 0100 and 0130 - 0200 on 9,833 9,540 7.305 and 6.234; 0300 - 0330, 0330 - 0400 and 0430 - 0500 on 9,833 7,305 7,215 and 6,234.

GERMANY. 5,970 5,985 and 6,105 are three of Radio Free Europe's frequencies which are on the air continuously from 0355 - 2400 on weekdays and 0555 - 2400 on Sundays. Each frequency carries a different foreign language programme.

SWAN ISLAND. Radio Americas has been heard broadcasting a Spanish language programme from around 2330 until 0700. Transmitter power is believed to be 7½kW. and the frequency is 6000.

CANARY ISLANDS. Radio Nacional at Tenerife is reported to be carrying a Spanish language programme on 11,800 from 0000 - 0300. However, this channel is used by Radio Nederland until 0200 and by Radio Ceylon after 0200.

From 1430 - 1600 this same station transmits on 9,660.

ETHIOPIA. ETLF, The Voice of the Gospel, has been heard recently on 9,660 from 1600 - 1630.

WATCH FOR OCTOBER ISSUE

A special Marine Electronics feature will contain articles on Radar, RT, FM V.H.F., Instrumentation, ship-to-shore stations, search and rescue work, inverters DC to DC. In addition we will run our regular features.

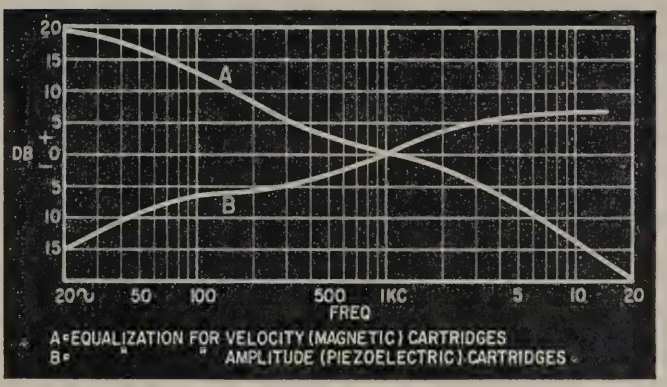


Fig. 1. R.I.A.A. playback equalisation curve for magnetic and crystal cartridges.

During development of some fully transistorised pre-amplifier circuits, which are to be used as part of our new All Silicon Transistor Stereo High-Fi, scheduled for publication next month, we came upon the problem of making the pre-amplifier suitable for use with a Radio Tuner, and Tape playback, as well as being compatable with the three basic types of pickups which could be used in conjunction with the amplifier.

Transistorised Pre-Amplifier Design Considerations

by I. H. Spackman

The three generic types of pickups are:—
1. The Ceramic Crystal cartridge.
2. The Rochelle Salt Crystal cartridge.
3. The magnetic type of cartridge.

Because the design considerations are intimately concerned with the characteristics of these three types of cartridges, we intend to discuss this month, some of the problems, coupled with some of the methods which have been put forward by others, to cope with these situations. This is being done now, to avoid bringing such discussions into the middle of next month's article.

To simplify the constructional side of the project we intend to publish two alterative pre-amplifier circuits, rather than introduce complications into one basic circuit to make it work with all types of pickups. Whilst this is done in some commercially produced units, it is not really necessary, when an amplifier will be constructed to fit in with existing equipment. Should a reader intend to start from the ground up, then he will be able to chose which ever particular design will ultimately suit his fancy, desire or purse.

1. The Modern Ceramic Cartridge

Some of the modern ceramic cartridges are capable of response, quality of reproduction, which makes them strong contenders for the position wihch to date has been exclusively held by the magnetic High Fidelity Pickup. This is particularly true when one considers their price, coupled with their compliance, and tracking weight figures, and the fact that when used with valve type amplifiers, very high input sensitivity is not required. Furthermore, many of the cartridges are so designed that they produce a near flat audio response from a R.I.A.A. recording when operated into the recommended load. But in the case of all transistor pre-amps, and some valve circuits, it is this value of recommended load which is a stumbling block.

As the quality of the ceramic cartridge has improved, so the output levels, in general, appear to have dropped; with output figures of from 50 to 150 mv./cm./sec. being quoted for representative types. This voltage is being developed across recommended loads of the order of 2 megohms, and it is necessary to retain this if the flat response is going to be maintained.

Even with most valve type pre-amplifiers, it is unusual to find input impedances as high as two megohms. Consequently, if a ceramic cartridge is connected straight into a normal pre-amplifier without suitable modification, there will be a loss of bass and the treble response and output may be affected also.

In general, both ceramic and rochelle salt type cartridges can be operated in one of two different ways.

(*a*) They can be used in the normal manner, that is, working into a high value of load resistance. In this way, they operate as amplitude devices, producing a signal voltage output proportional to the amplitude of the stylus movement.

(*b*) Alternatively, they can be used as a velocity device producing an output voltage proportional to the speed the stylus moves in the groove similar to a magnetic cartridge. This stylus speed depends not only on the amplitude of the programme, but also on the recorded frequency. Normally, to obtain the velocity effect, the cartridge is operated into a low value of resistive load, lying somewhere between 10K and 50K ohms.

Well! you will say, Don't worry any further — this will be ideal for transistorised equipment. However, as the article proceeds, you will find that it is not quite as simple as it looks, and that problems

can arise whichever way a ceramic cartridge is used.

The Ceramic Cartridge as an Amplitude Device: Generally when we look at R.I.A.A. playback equalisation curves, we do so from the viewpoint of the magnetic cartridge, which requires a large amount of bass boost, and treble cut as shown in Curve A in Fig. 1. But, from the viewpoint of an amplitude response, the R.I.A.A. equalisation, calls for a large amount of bass cut, and a moderate amount of treble boost as shown in Curve B, Fig. 1. Also, we stated earlier, many of the modern ceramic cartridges are alleged to produce a tolerably flat output from a R.I.A.A. recording. How can we reconcile these last two statements?

First Treble Boost: Like other physical devices, the ceramic pickup has natural resonances, and these generally occur near the high frequency end of the audible range. By proper design, including suitable damping, the resonance is controlled, so that it approximates the required treble boost as in Curve B. Hence the cartridge is indeed, self equalising for treble.

Bass Cut: The ceramic cartridge, and also the rochelle salt cartridge are both basically capacitive transducers, with typical capacitance values ranging from about 300 to 600 pf., although it may go a good deal higher.

Together with the load resistance presented by the amplifier, the cartridge capacitance plus other circuit capacitances, such as that of the connecting cable, and the input capacitance of the amplifier, form a simple bass attenuation circuit as in Fig. 2.

In this condition, the cartridge can be considered as an ideal generator, with zero impedance, working in series with a fixed capacity into a fixed load resistance. Thus, with the rising reactance of the capacitance with decreasing frequency, the bass is attenuated.

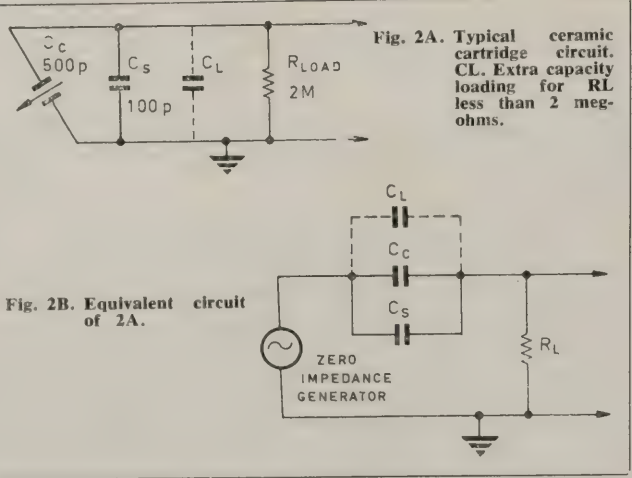


Fig. 2A. Typical ceramic cartridge circuit. CL. Extra capacity loading for RL less than 2 megohms.

Fig. 2B. Equivalent circuit of 2A.

The ceramic cartridge is not completely self-equalising in the bass region because it is very much dependent on the load resistance, and moderately dependent on the other circuit capacitances. If we want to reproduce the R.I.A.A. characteristic through the bass region, it is necessary to have a cartridge and stray capacity/load resistance time constant value of between 1200 and 1300 microseconds. A typical ceramic cartridge readily available in this country is the Sonotone 9TA. This cartridge requires 100 pf. extra capacity, together with a 2 megohm load resistance. This means that the capacity of the cartridge is approximately

$$\frac{1200 \times 10^{-6}}{2 \times 10^{6}} = 600 \text{ pf.} - 100 \text{ pf.} = 500 \text{ pf.}$$

It is unfortunate that the capacitance of cartridges from various manufacturers are somewhat different, but most of those commonly available in this country, for example the Decca Deram and the Sonotone 9TA are approximately 500 pf. Generally the trend these days is to specify the load, both resistive and capacitively to ensure a relatively level response.

Now if a ceramic cartridge is coupled across a lower value of load resistance, there will be too much bass cut. With our 1200 microsecond time constant, the bass will be 3 db down at 130 cycles, following the R.I.A.A. characteristic quite closely down to quite low frequencies. If we try to feed this same cartridge into a load of say ½ a megohm (300 microsecond time constant) then the bass will be 3 db. down at 500 cycles, and almost gone at 50 cycles.

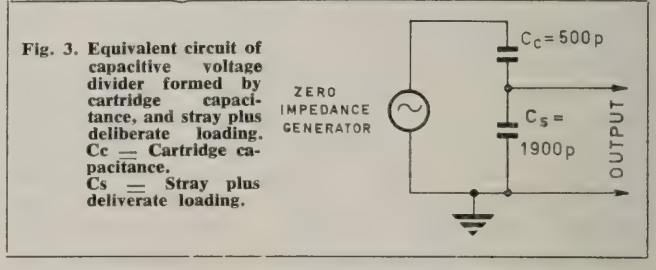


Fig. 3. Equivalent circuit of capacitive voltage divider formed by cartridge capacitance, and stray plus deliberate loading. Cc = Cartridge capacitance. Cs = Stray plus deliverate loading.

This problem has two solutions (1) Increase the load resistance, or (2) increase the circuit capacitance. The first is not a practical proposition with transistors, so the second choice is the obvious one. How do we calculate the value of this extra capacitance? Assume that the cartridge capacitance is 500 pf. as before, with cable and stray capacitance? Assuming that the cartridge capaci-load resistance is ½ megohm, to obtain a time constant of 1200 microseconds, the total capacitance is

$$\frac{1200 \times 10^{-6}}{5 \times 10^{5}} = 2400 \text{ pf.}$$

Therefore it is necessary to add 1800 pf. Now putting a capacitor across the cartridge will also tend to reduce the overall signal level, thus minimising any problem of overload. This is particularly important if a transistorised pre-amp is contemplated with its likely maximum signal handling ability of 100 mv. or so. The equivalent circuit of the capacitances is shown in Fig. 3, acting as a capacitive attenuator. These values given above, produce almost 14 db. of signal attenuation, that is, a reduction to nearly 1/5 of the original level.

The Ceramic Cartridge as a Velocity Device: We have discussed the treatment of the ceramic cartridge as an amplitude device — what of the second method we suggested; that of operating the cart-

ridge into a low impedance load, thereby converting the system into a velocity device. This, as explained earlier is not as simple as it first appears. The reason for this qualification is to be found in the presence of the built-in treble response, which gives the treble boost correction when the cartridge is operated as an amplitude device.

With a small resistor in series with the cartridge capacity, we get the same effect as we had present in the case of the bass cut, but the very small resistor causes the high pass effect to be present through the whole of the audio range, thus producing a rising response at the rate of 6 db. per octave, similar to the magnetic cartridge. In order to avoid excessive treble boost around the frequencies where the natural resonance effects appear, it is necessary to limit the rising characteristic at 5000 cycles or so, with the response levelling off above this. To do this, it is necessary to produce a circuit with a time constant of about 32 microseconds.

For example, if the cartridge and other circuit capacitances total 600 pf., the appropriate load resistor works out about 47K. ohms. This is not the only problem however, as the signal from the cartridge is generally great enough to overload the first stage if it is a transistor unit. Therefore it is necessary to reduce the signal voltage by some form of voltage divider. Either a resistive 10 to 1 divider can be used, or alternatively a capacity can be placed across the circuit as we did with the amplitude system, and then lower the resistance to maintain the 32 microseconds time constant.

For example, we can add 2700 pf. to our hypothetical 500 pf. cartridge and lower the load resistance to 10k ohms, thus still maintaining the 30 microsecond time constant but attenuating the signal level to about 1/6 of its former value.

Now, however, we must also provide compensation for a magnetic type pickup to correct for the R.I.A.A. curve. This seems to be rather a long winded way of obtaining the desired result.

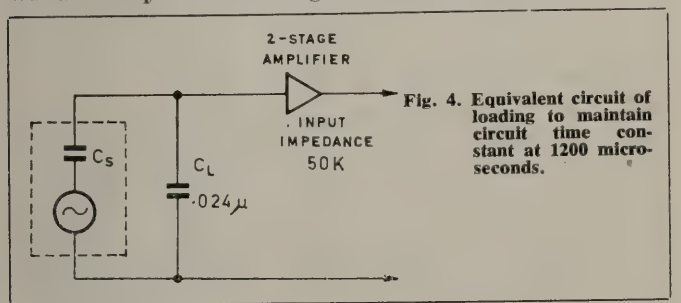


Fig. 4. Equivalent circuit of loading to maintain circuit time constant at 1200 microseconds.

Is there any other way — yes there is; and readers will probably have seen it by now. With a load of say 50 k. ohms, what capacitance is required to produce a circuit time constant of 1200 microseconds. Using our formula as before

$$C = \frac{1200 \times 10^{-6}}{5 \times 10^{4}} = .024 \text{ mfd.}$$

If this capacity is placed across our 500 pf. cartridge we will get nearly a 50 : 1 voltage division. Thus our cartridge with an output of 100 mv., will yield about 2 mv. at the preamplifier input socket. This method has been recommended for transistor applications, but requires at least two low noise transistors operating in tandem to bring the level back to the level originally produced by the pickup, (see Fig. 4.)

Noise is not a real problem, because of the low circuit impedances. The pickup still operates as an amplitude device, and therefore frequency compensation is not required.

A modification of this system, shown in Fig. 5, is typical of a number of current transistor designs such as those published by Towers[1], Mullard [2], Simpson[3] and others.

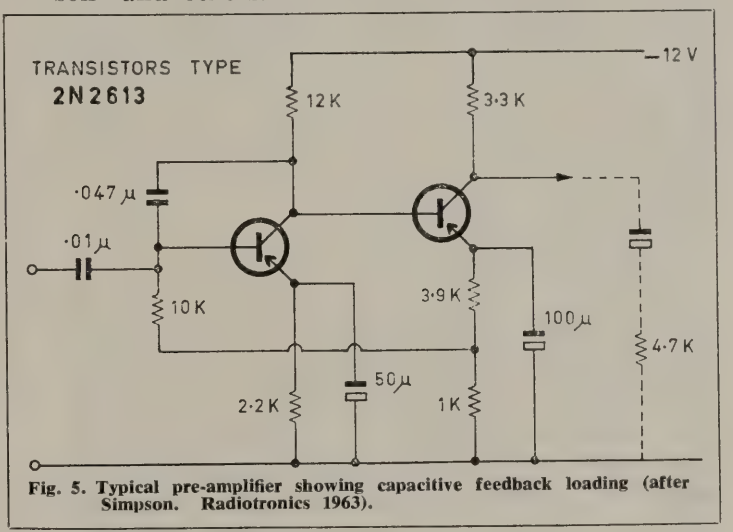


Fig. 5. Typical pre-amplifier showing capacitive feedback loading (after Simpson. Radiotronics 1963).

Here the large capacity loading is obtained by substantial capacitive feedback from collector to base of the first stage. This first stage is direct coupled to the second stage, and the D.C. conditions of both transistors are determined by the D.C. feedback from emitter of the second transistor to the base of the first transistor. Here again, two low noise transistors are required to raise the signal level up to about 100 mv., for application to the succeeding stages.

Practical Pre-amp Design: So far most of the preamplifier designs have utilised low noise germanium transistors with their temperature sensitivity and collector-base leakage current problems. It has therefore been necessary to keep the base circuit resistances relatively low, for good stability to be maintained. Recently however, a range of low noise NPN silicon transistors were released in New Zealand. Apart from all the normal redeeming features of silicon transistors, these new types have F_T figures of 60 megacycles, typical current gains of 150 or more, and are available at what one normally considers as germanium prices. With some samples of these, we took another look at the pre-amplifier position as it affects both ceramic and crystal pickups.

Consider a single emitter-follower amplifier with A.C. feedback from the emitter to the bottom of the base bias resistor (some call this a bootstrap emitter-follower), such that the input impedance of the device approaches ½ megohm. Then using this

figure and calculating the loading capacity to maintain a circuit time constant of 1200 microseconds we find that we need about 1800 pf. parallel capacity. The capacitive voltage divider so formed gives about 14 db (5 : 1) voltage reduction and with the shunting effect of the parallel capacity, very little noise is produced, so that a 100 mv. output pickup, reduced to one-fifth or approximately 20 mv. still gives a good signal to noise ratio. For simplicity such a circuit would be hard to beat. We get our amplitude loading, and a low impedance service to feed into the succeeding stage via a tone control, volume control or whatever is desired.

Such a circuit will also suit a conventional crystal pickup. With the capacitive divider present there is no likelihood that the higher output, normally produced by such pickups, will cause any overload effects, apart from the fact that the emitter-follower is extremely tolerant to applied signal level because of the follower action.

2. Rochelle Salt Crystal Cartridges

In general what has been said about ceramic cartridges, also applies to the conventional crystal cartridge. The loads required for flat response are generally between ½ and 1½ megohms, corresponding to transducer capacitances of 750 to 2000 pf. or so. Nowadays, in line with the general improvements in other types of cartridges, the modern crystal produces less output than its predecessors, but also is capable of much better frequency response characteristics. A typical example is the Ronette Stereo 105 cartridge which has a stated frequency response of 30c/s to 12Kc with a sensitivity of 250 mv./cm./sec. Its recommended loading is 1 megohm shunted by 100 pf.

3. The Magnetic Cartridges

There are quite a few of these being used now in conjunction with good Hi-Fi equipment in this country.

As mentioned before in conjunction with the velocity loading of a ceramic cartridge, the compensation required to correct a magnetic type cartridge for R.I.A.A. recording characteristic is bass boost and treble cut. The typical resistive load for these cartridges is in the vicinity of 50K. ohms, and the output ranges from 1 to 5 mv. One method of treatment for pre-amplification is to use the fact that a magnetic cartridge is effectively a generator with an inductive source impedance. If such a generator is fed into a low impedance resistive load, the load voltage will drop with increasing frequency. In other words, the pickup cartridge can be visualised as a voltage generator in series with an inductor, whose reactance decreases as the frequency decreases. At very low frequencies the inductive component is so small that it does not affect the generator voltage appearing across the load. As the frequency is increased, provided the load is relatively small, less voltage will appear across it because of the increasing reactance (resistance) of the inductive part. This then gives an approach to the correct compensation for the R.I.A.A. curve.

Most magnetic cartridges designed to work into medium impedance loads will probably have sufficient internal inductance to produce a great proportion of the required boost. The addition of some supplementary compensation in the form of a frequency selective feedback network, usually fills the bill nicely. (See Fig. 6.)

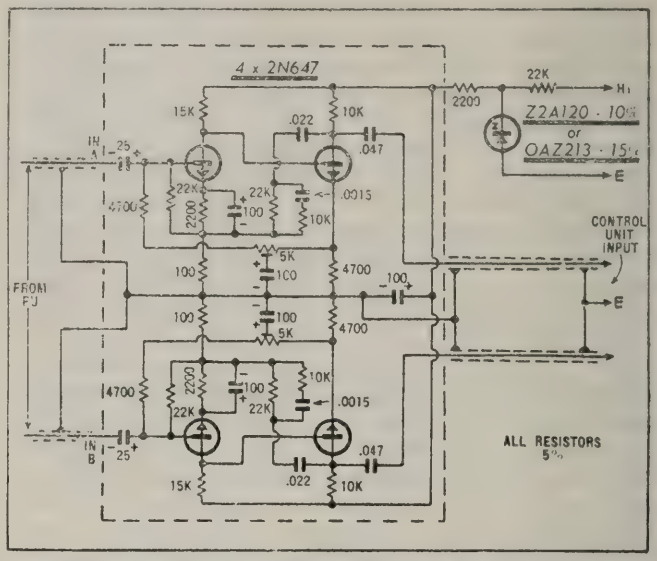


Fig. 6. Preamplifier for magnetic pickup utilising the internal inductance of the pickup for frequency compensation. (After J. Rowe — R.T.V. and H., August).

A second method is to create an input impedance of the order of 50K. ohms, and provide all the frequency compensation by means of frequency selective feedback. Whilst the first method mentioned above is ideal for use specifically as a remote, (under motor-deck), mounting; low noise, and hum free preamplifier, solely for a magnetic pickup, it does not lend itself so well to inclusion as a "pre-amp" where other devices such as a radio tuner, a tape playback head, or even a crystal pickup may also be employed. There has also been some suggestion that the full compensation method may give somewhat smoother response, but this has not been investigated in detail by the author.

The circuit developed is basically quite simple. Once again the new silicon transistors are used and a two stage direct coupled amplifier is employed with the first stage base resistor returned back to the emitter, in a "boot-strapped" manner to give a high input impedance. This enables us to shunt the input with a resistor to bring the impedance down to the desired level.

Frequency selective feedback is provided from the second collector to the first emitter, via a capacitor which controls the bass response, and a parallel combination of a resistor and capacitor which respectively set the level at the cross-over point, and control the high frequency roll-off.

This design is capable of handling quite a high level before overloading occurs, but this is dependent mainly on the supply voltage available.

Continued on page 33

Mobile Communications

Part IV

by Countryman

AMPLITUDE MODULATION versus FREQUENCY MODULATION

Nearly all the mobile communication in the VHF bands in New Zealand uses amplitude modulation, that is the type familiar to us all from standard broadcasting. In this respect N.Z. is out of step with the rest of the world where the majority of land mobile on VHF is frequency modulated. It is no secret that the Post Office, who in this country are the licencing authority, have refused the use of frequency modulation for mobile, up until fairly recently, although curiously enough they are an extensive user of FM on their own point to point circuits.

In the last few years however, a number of users have received approval for the establishment of mobile networks using FM, and there is no doubt that its use will grow because it can, in some circumstances, offer definite advantages over AM. Indeed there are services where its use can be the difference between a good service and virtually no service at all.

Most people are familiar with the use of FM for the sound part of TV, and its use overseas for VHF hi-fi and stereo broadcasting, but its use in mobile communication is not so well known. With TV and FM broadcasting a deviation ratio (maximum deviation frequency divided by maximum modulation frequency) of about 5 is used. That is with an audio bandpass of up to 15kc/s the greatest deviation will be ± 75 Kc/s. A number of different standards are in use for Mobile, depending largely on the country concerned. Older systems are based on the wide (50Kc/s) channelling and use a 3 kc/s audio bandwidth with 15Kc/s deviation. Newer systems use the 3kc/s bandwidth, but the deviation has been reduced to 5kc/s, a deviation ratio of about 1·7. With this type of system channelling may be reduced to 25 Kc/s, which, with present day state of the art, appears to be the limit if any advantage is to be gained from the use of FM. Incidentally this channel spacing is only now coming into use for AM in N.Z., and it means that given reasonable geographical spacing quite a few coincident channels may be used.

FM differs from AM in that when the carrier is being modulated the sidebands extend, in theory anyway, to infinity, as opposed to AM where the sidebands only extend out from the carrier as far as the highest audio frequency, on both sides, of course. In practice of course it isn't necessary to have an infinite bandwidth, and the CCIR define the FM bandwidth as (2Fm + 2Dk) where Fm is the audio bandwidth and Dk is the maximum deviation frequency, so that for the narrow band system mentioned above the bandwidth would be 16Kc/s, or in code 16F3. To this bandwidth would have to be added the tolerance of the centre frequency permitted. For instance if the permitted tolerance is 0·0005% then at 150 Mc/s the carrier may be as far as ± 1·5 Kc/s away from the nominal frequency.

What advantages does FM offer over the conventional AM system? First and foremost is the generally improved reception. With AM the signal to noise ratio falls off as the signals weaken until the modulation no longer is easily readable. With signals of the order of a microvolt or so the signal noise ratio may be well below 10dB. With FM, because of the inbuilt limiting effect, this fall off is not so noticeable. Provided the signal is over a certain level (the onset of limiting) the signal to noise ratio will be more or less constant. Thus with a well designed FM receiver signals as low as 1 microvolt will produce s/n ratios of 20dB or better. Secondly there is no gradual fadeout of signal as you move away from the base station. The signal remains clear until the limiter ceases to operate, and then ceases to be readable. A pretty definite service area can therefore be set to the base station.

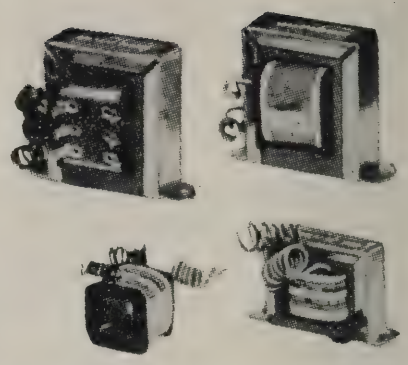
Ignition interference, always a bugbear where signal strengths are low is not so troublesome on FM, provided that the limiter is being saturated by the wanted signal. Even when signal strengths are quite low the effect of ignition or other impulse noise is to produce an audio "hole" or to blank the signal, rather than to produce the loud buzzing heard in AM sets.

A very important effect of FM is the "Capture Effect". I have seen this defined in several ways but for the purpose of this article I will use the term to mean the ability of the strongest signal on any frequency to capture the detector, and to suppress the other signals on the frequency. Putting this into practical terms, let us imagine two signals on the same channel one twice as strong as the other. With an AM system the signals will beat together (Provided they are not **exactly** on the same frequency) and provide a very strong audio note. This tone will usually be strong enough to make the signals unusable. With FM on the other hand the stronger signal will suppress the weaker and the beat will be reduced far below the audio level, the exact degree of suppression depending on the efficiency of the limiter circuits. This effect has great utility when it comes to covering a large area for a mobile system. With AM and FM where the area to be covered is larger than can be covered with one repeater station it is necessary to use two or more. With AM, however, in order to avoid the beat notes the carriers must be spaced about 10Kc/s apart so that the heterodyne is outside the audio bandpass of the receiver. With two repeaters the bandwidth occupied will be thus 6kc/s + 10kc/s, i.e. the same spectrum space as the FM system. When three repeaters are required the bandwidth for the AM system becomes 26kc/s + the transmitter frequency tolerance. Brinkley has shown that to give complete area coverage four different repeater frequencies are needed, thus extending the bandwidth of the system to the order of 40 kc/s.

ENQUIRY CARD AD. 14

OUTPUT TRANSFORMERS to your requirements

by ATC



We Manufacture many types of Output Transformers for New Equipment and Replacement Repair Work.
WINDINGS AVAILABLE FOR OP1-14 and OP18-22 INCLUSIVE

Type No.	Wattage	Impedance Ratio	Bobbin Size	Colour Code	Mounting
†OP1	3	5K/3 ohms	9/16 Square	Red	Clamp
†OP2	3	7K/3 „	9/16 „	Yellow	„
†OP3	3	10K/3 „	9/16 „	White	„
†OP3 C	3	10KCT/3 ohms	9/16 „	White	„
†OP4	6	5K/3 „	¾ Square	Red	„
†OP5	6	7K/3 „	¾ „	Yellow	„
†OP6	6	10KCT/3 „	¾ „	White	„
†OP7	6	14KCT/3 „	¾ „	Black	„
†OP8	4.5	5K/3 „	11/16 x 13/16	Red	„
†OP9	4.5	7K/3 „	11/16 x 13/16	Yellow	„
†OP10	4.5	10KCT/3 „	11/16 x 13/16	White	„
†OP11	4.5	14KCT/3 „	11/16 x 13/16	Black	„
†OP12	4.5	Universal	11/16 x 13/16	—	„
†OP13	6	Universal	¾ x ¾	—	„
†OP14	10W	Universal	⅞ x ⅞	—	„
OP15	20	5KCT/Univ.	1" x 1¼	—	Side covers & feet
OP16	20	6.6KCT/ „	1" x 1¼	—	„
OP17	20	10KCT/ „	1" x 1¼	—	„
OP21	2W	5K/3	½"	Red	Windings Only
OP22	2W	7K/3	½"	Yellow	„ „
OP23	35W	5KCT/Univ.	2" x 1¼	—	Covers & Feet
OP24	35	6.6KCT/ „	2" x 1¼	—	„ „
OP25	35	10KCT/ „	2" x 1¼	—	„ „
OP26	15W	Hifi 5KCT/15 ohms	2" x 1¼	—	„ „
OP27	15W	Hifii 8KCT/15 „	2" x 1¼	—	„ „
OP28	15W	Hifii 10KCT/15 „	2" x 1¼	—	„ „
		ULTRA LINEAR TYPE			
OP29	20W	6.6KCT/15 ohms	2" x 1¼	—	„ „
OP30	20	8.5KCT/15 „	2" x 1¼	—	„ „
OP31	20	10KCT/15 „	2" x 1¼	—	„ „
		LOW POWER EXTENDED RANGE			
OP32	6W	8KCT/7 ohms	1¼" x ⅞"	—	Clamp
OP33	6W	8KCT/15 „	1¼" x ⅞"	—	Clamp
OP34	3W	Universal	9/16 x 9/16	—	„
OP35	6W	10KCT/15-7.5-3 ohms	¾ x ¾	—	„
OP36					
OP37 / OP50	8W U/L / 10W stereo	9KCT/15-7.5-3 ohms	⅞" x ⅞"	—	„

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In addition the receiver bandwidth must also include this range, and as is well known the wider the bandwidth of a receiver the more noise it lets in, so that the system is going to suffer some degredation of performance from this cause.

On the other hand, all the FM system's repeaters may be placed on the same frequency, and there is no increase in bandwidth for a multiple repeater system. There will be some audible interference between repeaters, but in actual practice, this is unlikely to reach serious proportions even in areas of approximately equal field strength, because a movement of only a few inches is going to cause big variations between the signals so that one or the other will predominate.

It will be seen from this discussion that one of the big arguments put up against FM, that it wastes spectrum space, is not always the case, and indeed where a large area is to be covered, or an area where signal attenuation is likely to be high, such as in a forest, the use of FM will actually conserve spectrum space.

Most mobile systems work on a "repeater" basis. That is the incoming signal from the mobile or the base station is received, processed and retransmitted on another frequency. This means that there is no direct communication from set to set, even when they are adjacent. All stations transmit on "A" frequency which is received at the repeater site, and reradiated on "B" frequency to which all receivers are tuned. This enables the repeater to be located at a suitable point to provide area coverage, such as on top of a high hill or mountain. Signals which arrive here are likely to vary a good deal in strength, and the receiver must accept a wide range of signals and still modulate the transmitter fully. This is likely to involve complex limiting systems in AM. With FM on the other hand provided the limiting stage is operated by the incoming signal the output of the receiver will remain within a dB or so of standard level and is repeated with virtually no loss of quality and without any fading. The repeater won't mind if its getting 1 microvolt or 100 millivolts so long as the limiter stage is saturated.

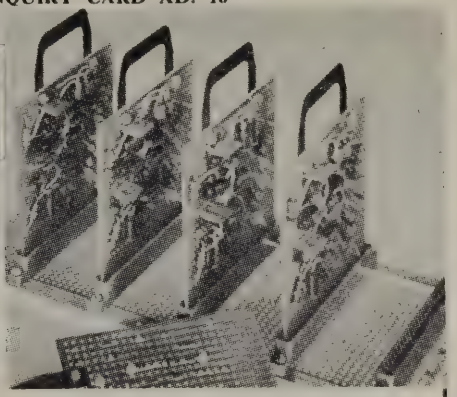
Readers will probably gather by now that I am an FM fan. I have heard several of these systems in operation and discussed them with both users and technicians. Users are unanimous in preferring them to AM systems, and although this can perhaps be taken with a grain or two of salt, the technician's opinions are about the same. In addition they say that the FM system is easier to maintain than the equivalent AM system, largely because of its tolerance of signals of widely varying strength.

Overseas it is becoming practice for mobiles in vehicles to be interconnected with telephone systems. The advantages of this to people like doctors, fire chiefs, and police should be readily apparent. The Post Office is very jealous of the high standard of speech quality allowed on its lines. and if mobile phone systems are to be used in N.Z. then it is likely that only FM will provide the consistent quality required.

ENQUIRY CARD AD. 16

vero board

A new concept in circuit design and assembly



Veroboard is a universal wiring board manufactured from a high grade copper clad S.R.B.P. laminate to very close tolerances. Its use enables printed circuit techniques to be employed both in the laboratory and in subsequent production without the high cost and delays associated with this type of work.

The spacing of the copper conductors and the hole matrix conforms with the B.S. and International recommendations, enabling a large variety of printed circuit and normal wire-ended component to be used to achieve neat and compact units. It will be found that the Veroboard Circuit System can be used in the construction of any electronic circuit.

Veroboard is ideal for experimenters . Veroboard is reasonably priced, versatile and re-usable. Production men benefit from Veroboard too, it is always available and of consistent quality.

VERORACKS

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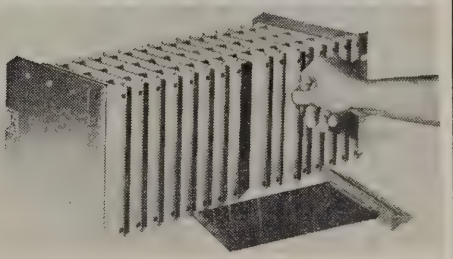

New extruded guides for use in the Verorack assembly are available. Although designed primarily for use with Veroboards, the guides will accept any card up to 1/16in. thick.

All guides are ready drilled for assembly on ties bars, and are machined at one end to provide a card lead in, and at the other to accept an edge connector. Bankloc 6BA threaded inserts are fitted at each end of the guides for attachment of an edge connector or to retain a handle. A new design of edge connector mounting rail for use with the Verorack assembly enables connectors to be positioned wherever required.

Further information about time-saving Veroboards and Veroracks will be given by return mail.

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ENQUIRY CARD AD. 17

SILICON DIODE POWER TRANSFORMERS AVAILABLE FROM BEACON RADIO LTD.

R98 T.V. POWER TRANSFORMER

For R.T.V. & H. 1959 and later T.V. Sets.
Delivers 260v @ 300mA D.C. Full wave voltage doubler.
230:115v A.C. @ 300mA D.C.
:12.6v C.T. @ 5A (2 windings ea. 6.3 @ 5A).
:0—6.3—7.5—9 @ .6A. Picture tube winding.
Choke:—C36. Use 400v P.I.V. Diodes.

R103 Stereo Power Transformer

R.T.V. & H. Aug. 60. 7w Stereo.
230:245v @ 150mA. D.C.
:104v @ 150mA D.C. Voltage doubler Rect.
:6.3v C.T. @ 5A.
Choke:—C42. Use 400v P.I.V. Diodes.

R104 Stereo Power Transformer. 10w

320v @ 320mA. Voltage doubler Rect.
230:130v @ 320mA.
:6.3v @ 6A.
Choke:—C49. Use 500v P.I.V. Diodes.

R105 T.V. Power Transformer For Philips T.V. Kitsets

220v @ 420mA D.C. Voltage Doubler Rect.
230:106v @ 420mA D.C.
:6.3v @ 10A.
:0—6.3—7.5—9 Ov @ 0.3A. Picture tube Winding.
Choke:—C45. Use 400v P.I.V. Diodes.

R106 T.V. Power Transformer for Philips T.V. Kitsets

This type similar to R105 but less Picture Tube boost taps. Main Fils. 12.6v C.T. @ 5A.
220v @ 420mA D.C. Voltage Doubler Rect.
230:106v @ 420mA D.C.
:12.6v C.T. @ 5A (2 windings 6.30v @ 5A each).
:6.3v @ .3A Picture tube winding.
Choke:—C45. Use 400v P.I.V. Diodes.

R108 Small Stereo Headphone Power Transformer

250v @ 22mA D.C.
230:110v @ 22mA D.C. Voltage doubler Rect.
:6.3 @ 0.86A.
Choke:—C41. Use 400v P.I.V. Diodes.

R110 T.V. Power Transformer. For Philips T.V. Kitsets

This transformer uses full wave bridge rectifier. Requires no limiting resistor unlike equivalent voltage double types, also has advantage of no insulated capacitor and lower ripple output with smaller choke.
Output 220v @ 420mA D.C.
230:172v @ 420mA D.C. Full wave bridge Rect:
:12.6v C.T. @ 5A (2 only 6.3v winding @ 5A).
:6.3v @ .3A Picture tube winding.
Choke:—C50. Use 400v P.I.V. Diodes.

R111 T.V. Power Transformer

Similar to R110 but for R.C.A. type Kitsets.
260v @ 350mA from Rect.
230:207v @ 350mA D.C. Full wave bridge Rect.
:12.6v C.T. @ 5A (2 only 6.3v windings each 5A).
:6.3v @ 0.6A. Picture tube winding.
Choke:—C42. Use 400v P.I.V. Diodes.

R112 Oscilloscope Power Transformer

R.T.V. & H. 1963. Calibrated.
230:110v @ 80mA D.C. Full wave voltage doubler.
:6.3v @ 2.4A.
:6.3v @ 1A.
:6.3v @ 1A.
Use 400v P.I.V. Diodes.

BEACON RADIO LIMITED

Corner Brown and Fitzroy Sts., Ponsonby, Auckland. P.O. Box 2757. Telephone 16-164 (3 lines)

Transistorised Pre-Amplifier Design Considerations

Continued from page 28

The distortion figures are good — better than .05% whilst the signal to noise ratio at 5 mv. input level is better than 60 db.

We have given a prelude to our forthcoming "Hi-Fi" project and hope that the subjects we have discussed this month will give a clearer picture of the operation of the various parts of the final design.

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3. "Ceramic Pickup Cartridges", Radiotronics, October, 1963 and "Crystal Pickup Cartridges", Radiotronics, November, 1963. Both by B. J. Simpson.
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6. Looking at "The Crystal Pickup Cartridge", Radio & Electrical Review, January, 1962.
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British Astronomers Have New Radio Telescope

A new one-mile radio telescope has been installed for the Science Research Council at Mullard Radio Astronomy Observatory near Cambridge in England, and here the movable reflector is seen. The reflector, which is 60 feet in diameter, runs along a ½ mile track and is moved by a hydraulic motor which allows precise control at very low speeds. The construction of the telescope started in 1962, with the aid of a grant of £570,000 from Britain's former Department of Scientific and Industrial Research.

Erection Of Mt. Te Aroha Television Tower

Atop Mt. Te Aroha 3,126 feet above sea level, a 400 foot self-supporting steel tower is being erected. Atop this tower Marconi quadrant aerial elements will be mounted. This television array, fed by parallel Marconi transmitters, will radiate an effective power of 100 KW on Channel 1, with vertical polarisation. The tower will be visible in the Bay of Plenty, the Hauraki Plains and the Waikato.

When the new installation is commissioned, a significant improvement will result in the television coverage over this extensive area. The Te Aroha station will radiate the television programme originated in the studios of Channel 2, Auckland, and carried to this repeater site by AWA microwave links.

The Te Aroha installation is part of a major contract awarded Amalgamated Wireless (Australasia) N.Z. Limited last year for aerials, towers and high power transmitters for Auckland, Te Aroha, Wharite (near Palmerston North), and Christchurch.

The township of Te Aroha look Lilliputian through a gap in the clouds from the site now being developed on the mountaintop for the high power television station.

ENQUIRY CARD AD. 18

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Osc. Type 41

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ENQUIRY CARD AD. 19

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Look hard - really hard, for behind every Miniwatt trade-marked tube stands a worldwide organisation of repute and renown. An efficient organisation with top-ranking scientists in metallurgy, chemistry, electronics, physics..., vast laboratories..., thousands and thousands of specially trained workers. experience of many years of manufacturing... and these are but a few aspects of what goes into producing tubes of top-quality..... Miniwatt tubes. What does this mean to you?

YOUR GAIN!

And not only your gain - but your customers' as well! For your customers rely upon you to do a good job when their sets need repair. And satisfied customers will come back and buy from you again and again. Miniwatt makes for satisfied customers. They know they can rely on you, you know you can rely on Miniwatt... always to have the right tube in stock... always a guaranteed top quality... and to render you the service only a leading manufacturer can - both now and in the future!

A WORLDWIDE ORGANISATION IS BACKING UP YOUR BUSINESS

PHILIPS

PHILIPS MINIWATT

CAMERA — VIEW —

Sample Electronics (NZ) Ltd.
8 Matipo St., Onehunga, Auckland, S.E.5.
Phone: 565-361, Code Address: ELPMAS.
Manager: Derek Barlow.

The question of after-sales service and calibration is one that too often plagues purchasers of electronic equipment in this country and it is pleasing to report in this issue the setting-up of a calibration room by a local company. Sample Electronics (N.Z.) Ltd. have been importers of a wide range of measuring equipment for several years and their Manager, Mr. Derek Barlow, feels that their success must be backed by adequate technical facilities. Recently this was implemented by setting up a calibration and service room at their premises in Onehunga.

Samples represent a number of companies, mostly American, dealing in precision and nucleonic measurements and the long-term accuracy of such equipment cannot always be checked by the purchaser regularly. Whilst Sample's facilities are by no means complete as yet, frequency measurements with an accuracy of one part in 10^7 over the range DC to 500 Mc/s can be done and a DC and AC voltage calibrator unit allows calibration of VTVM's or oscilloscopes over the range 300 μV to 300V with an accuracy of ± .25% on DC and ± .5% on AC. RF power measurements in the range 10 Mc/s to 10 Gc/s with an accuracy of ± 3% at levels 1μW to 10mW are also possible.

The calibrator set is shown at the rear in figure 1 and comprises a Hewlett Packard 200 SR oscillator, a 739 AR frequency response test set and a 200 738 BR voltmeter calibrator. The 738 BR provides a 400 c/s test signal for AC calibration of equipment. The 739 AR and 200 SR allow the response characteristics of VTVM's and CRO's to be checked from 10 c/s to 5 Mc/s with an accuracy of .5% and from 5 c/s to 10 Mc/s within 1.5%.

Atop the calibration set is a Datapulse 106A Pulse Generator. A 431B Power meter sits on top of a 175 A 50 Mc/s oscilloscope (this is shown in more detail in figure 2) and to the right on top is a 410c voltmeter. To the right of the oscilloscope is an HP 400 D Vacuum Tube Voltmeter.

In the foreground of figure 1 are a 5245L counter and 651A Test Oscillator. This test oscillator has a frequency range from 10 c/s to 10 Mc/s with a stability of 10 parts per million and a dial accuracy of ± 2%. Measuring accuracy of 1 in 10^7 can be achieved by using the 5245L counter as a frequency meter to monitor the oscillator output. The two vacuum tube voltmeters allow general-purpose measurements of voltage and current up to 700 Mc/s.

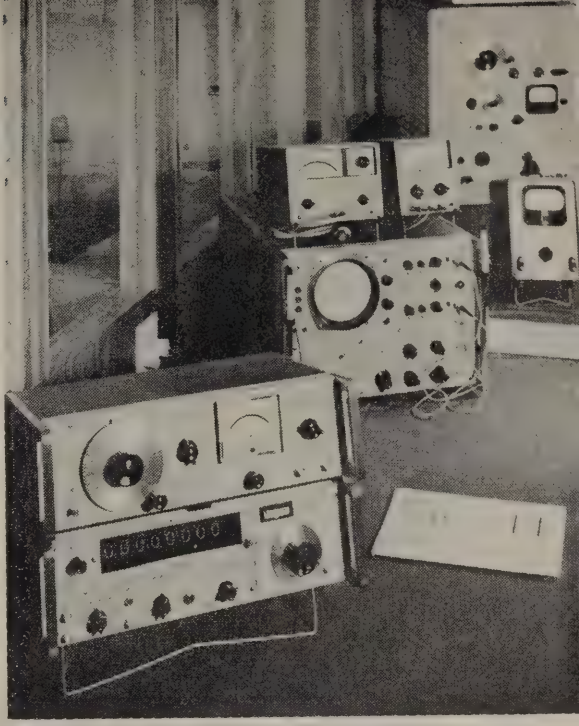


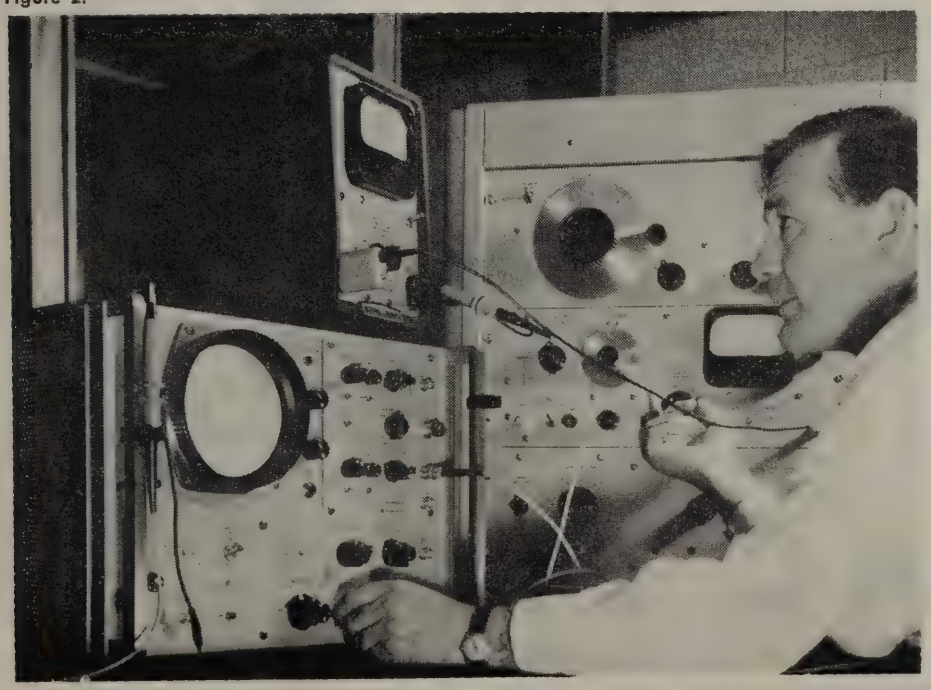
Figure 1.

Future plans of Sample Electronics include provision for a standard frequency transmision receiver, so that even more accurate frequency measurements can be made and also so that the inherent accuracy of their laboratory equipment can be standardised from time to time.

It seems to us that heavy investment in such laboratory and servicing is necessary not only to provide adequate maintenance of exciting equipment but also in the interests of future sales. After-sales service — a field in which the New Zealand customer has tended to be inadequately treated — has always been important and is going to become more so. This month's report shows an answer to the problem.

Sample Electronics can offer technical assistance in most measuring and instrumentation situations and this is backed up with a full information and catalogue service. Whilst based in Auckland, the Company offers Dominion-wide assistance both at a technical and calibration level — the latter extending to any make of equipment for which they are agents.

Figure 2.



PHILIPS OSCILLOSCOPES

Type and Bandwidth	Max. Sensitivity	Input Impedance	Signal Delay	Sweep Speeds	Magnifier	CRT Dia.	Acc. Voltage
GM 5603 differential wideband d.c.-14Mc/s	50mV/cm	1 MΩ//22 pF	yes	0.2μs/cm-1s/cm	2X, 5X	13cm (5″)	10kV
GM 5602 wideband d.c.-14Mc/s	50mV/cm	1 MΩ//22 pF	yes	0.2μs/cm-1s/cm	2X, 5X	10cm (4″)	4kV
GM 5600X compact H.F. d.c.-5Mc/s	50mV/cm	1 MΩ//40 pF	no	0.5μs/cm-30Mc/s/cm	—	7cm (3″)	1.6kV
PM 3201 H.F. d.c.-5Mc/s	10mV/cm	1 MΩ//35 pF	no	0.5μs/cm-0.2s/cm	5X	10cm (4″)	3kV
GM 5601 H.F. d.c.-5Mc/s	100mV/cm	1 MΩ//30 pF	no	0.5μs/cm-0.2s/cm	5X	10cm (4″)	3kV
PM 3236 double-beam L.F. d.c.-150kc/s d.c.-300kc/s	500μV/cm 20mV/cm	1 MΩ//70 pF	no	10μs/cm-5s/cm	2X, 5X, 10X	13cm (5″)	4kV
GM 5659 X.Y. d.c.-1M	100mV/cm	1 MΩ/15-40 pF	no	2μs/cm-0.1s/cm	—	10cm (4″)	2kV

QUALITY ENGINEERED FOR QUALITY SERVICE

The PM 3236 Double Beam Oscilloscope, brief details of which are given above, is a new addition to the Philips range, especially suitable for studying low frequency phenomena. This versatile instrument is available ex stock at a very attractive price.

For further information please contact:

EDAC

EDAC LTD.

P.O. BOX 6415, WELLINGTON **P.O. BOX 9338, AUCKLAND**

Serviceman's Column

Continued from page 23

The unit has 2-inputs each, individually controlled. The circuit has resemblances to the "Mullard 10" but differs in important details. The input stage is one half of a twin triode ECC83 which feeds separate bass and treble booster-cutters. The second half of the twin triode is the "usual" input stage to which the main feedback loop is connected.

The amplifier retails in U.K. at £14 14s. which means that the manufacturer operates on marginal costings. The equipment does — unlike some competitors from other lands with vivid imaginations — meet its published specification. However the unit runs right up to limits which means that a modicum of common sense should be used in installation.

The transformer primary and rectifier output are both fused. Switch-on after a few seconds off will produce a current surge guaranteed to blow the rectifier fuse. A 500ma type instead of the 110 ma type is a desperate but effective final measure. Check that the mains tap is set at 230 volts, this will melt the wax coatings on both power and output transformers but will not cause a burn-out. We invariably find these set for 250 volts and have to replace valves which have failed through low emission. Another favourite device is to leave off the base plate to permit extra component ventilation. Put it back, if the manufacturer could have saved himself all that nicely painted metal plate he would have done so. It is a shield so use it.

My most recent call was a horrible event. The amplifier had been mounted vertically and all the above "improvements" made. In addition two valve sockets had failed; one having a short on the screen of one EL84 which caused local burning in the output transformer and a 300 ohm leakage between the two sections of the output transformer. Besides a leaking balance condenser in the grid circuit of the phase-changer stage, we also replaced both output EL84 valves. The first ECC83 had also become noisy and erratic. The customer was faced with the expense of a visit during which the base plate was eventually found and the necessary screws added to his account. As a postscript to this expensive occasion the owner is now very satisfied and rang after the weekend to say so.

The previous two "Diatonics" had been modified to "improve" the circuit. Both had attempted to omit the first stage: in one case to lower "hiss", in the other to avoid an ultra-sonic parasitic which caused distortion at comparatively low outputs. After restoring the circuits to the makers original specification both were remedied by base-plates, new valves where cathode poisoning was irrevokable, and correct voltage operation. In one case the valves which had produced the parastic recovered after a week of operation at correct heater voltage and were then let off on probation. The owner was asked to report back if trouble struck, now five months later he is still happy.

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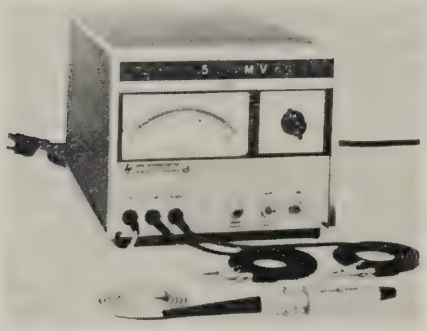

AUTORANGING DC VOLT-OHMMETER

A new 12-range all-solid-state dc volt-ohmmeter from Hewlett-Packard gives accurate measurements immediately, with automatic ranging. The Model 414A Autovoltmeter silently selects correct range and polarity less than 300 milliseconds after contact is made. Both range and polarity appear on an illuminated display; the reading appears on a mirror-backed, individually calibrated taut-band meter.

DC voltages are measured at sensitivities from 5 millivolts to 1500 volts full scale. Accuracy is ±0.5% of reading ±0.5% of full scale. Input resistance is 10 megohms on the two lowest scales, 100 megohms on full-scale ranges from 50 millivolts up.

Resistance is presented on linear scales with full-scale ranges from 5 ohms to 1.5 megohms. Illuminated characters are used to display the full scale resistance value as well as voltage for the measuring range which has been selected. Current through the unknown is 1 milliampere up to 5000 ohms, 1 microampere above 5000 ohms. Accuracy is ±1% of reading ±0.5% of full scale on all ranges.

The HP Model 414A was designed to serve bench and production operations, where widely differing readings are wanted in rapid succession. It offers speed and the convenience of analog analysis at relatively low cost.

The meter's input is floating, and may be operated up to 500 vdc above ground. The modular cabinet is less than 7 inches high, 7 5/8ins. wide, and 12ins. deep. It is readily rack-mountable by means of available accessories.

ENQUIRY 185

* * *

CIRCUIT-BOARD MOUNTING BRACKET

Nylon mounting brackets for printed-circuit boards provide an easy way of fixing the boards firmly to the frontpanels of cabinets. Each bracket is bored and channelled along its length to receive small nuts and bolts, and at the end where it is attached to the panel has a threaded metal insert to take the holding screw. Inserts are available with British, European and North American threads.

ENQUIRY 199

* * *

HIGH – EFFICIENCY SPEAKERS

A local firm announces a new range of high-efficiency speakers which require only half the electrical power input to provide the same acoustic power output as ordinary types. The slim dimensions of this range make them especially suitable for use in portables. These small Ferrite models, we are told, perform as well as or better than larger units using Alnico magnet motor units.

This is a sample dimension of one unit in the range.

Overall diameter of diaphragm housing: 3 9/16" x 3 9/16"
Diameter of Baffle opening: 3 3/16"
Diameter of Voice coil: ⅝"
Depth from pad ring to rear: 1¼" (1⅜")

One specification reads:—

Power Handling Capacity:
D 3 Watts Peak
G 3½ Watts Peak
Fundamental Resonance: 130 c.p.s.
Frequency Response: 15 ohms to 400 c.p.s.
Voice Coil Impedance: 15 ohms at 400 c.p.s.
Air Gap Flux Density: D 7,800 Gauss
G 11,000 Gauss
Total Gap Flux: D 13,000 Lines
G 18,400 Lines

Specifications are available for others in this interesting new range.

ENQUIRY 209

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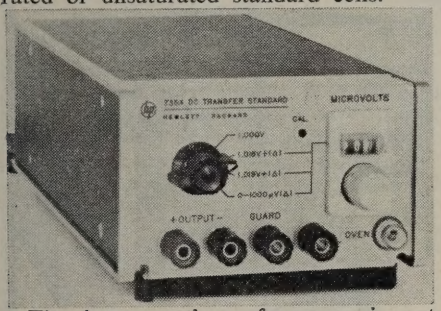
AUGUST, 1965

COMPACT INSTRUMENT TRANSFERS STANDARD VOLTAGES

A readily portable, highly usable standard volt is one of many available outputs from a compact new Hewlett-Packard dc transfer standard. With 1 microvolt resolution, the HP Model 735A may also be set to deliver 0 to 1000 microvolts, or any value between 1.018 and 1.020 volts.

Uses for Model 735A include service as a 1.000 volt reference for volt box potentiometric measurements, or as a transfer reference for comparing saturated or unsaturated standard cells.



The instrument's performance is not impaired by accidental short circuits. As a source, its internal impedance is low and specified constant within 1%, making its effect easily calculable. This output is also floating and guarded, for thorough isolation from power lines. Five-way binding posts are provided; positive and negative posts are gold-flashed solid copper, minimizing contact effects.

Day-to-day practical usefulness of the 735A DC Transfer Standard is further emphasized by its relative freedom from temperature effects and drift. Within the range 0° to + 50° C, the temperature coefficient is 1 ppm/°C, and stability with time is better than 10 ppm/month.

The modular enclosure, easily rack mountable with other instruments, is less than 3½" high, 5¾" wide, and 11" deep. Weight is only 5½ pounds.

ENQUIRY 184

* * *

THE TRANSDEVEL

This instrument has been designed to build quickly a transistor circuit for observation and re-design without using a single component except for the transistors. No soldering iron has to be used — experimental circuits can be set up in a few minutes.

The circuits that can be built with the Transdevel are practically unlimited; for example: Cascade-, Cascode-, Push/Pull-, and Differential Amplifiers, Phase Shifters, several Multivibrators, Trigger circuits, Limiters, Oscillators, Logic circuits and many others.

The frequency range is restricted to 10 Mc. being the parallel capacitance of the transistor-input clips (approx. 12 micromicrofarad) and the decade resistors (also approx. 12 micromicrofarad). When scaling a circuit one has to consider the maximum dissipation of the built-in resistors being 250 mW.

The instrument has a symmetrical lay-out and is designed to set-up two-transistor circuits. Around the transistor-input clips 8 decade resistors have been arranged, 6 of which have 2 decades (the R12 series) the other 2 have 4 decades (the R6 series).

With these decade resistors it is possible to put any desired value of the series into the circuit by means of the jumpers and patchcords supplied with the set.

All resistor terminations are double-ended. The power required can be taken from internal batteries or from an external power supply. The value of battery voltages can be chosen at the back of the Transdevel in steps of 1.5 volts.

On the front-panel it is possible to use two voltages and ground-potential at 6 different points.

ENQUIRY 211

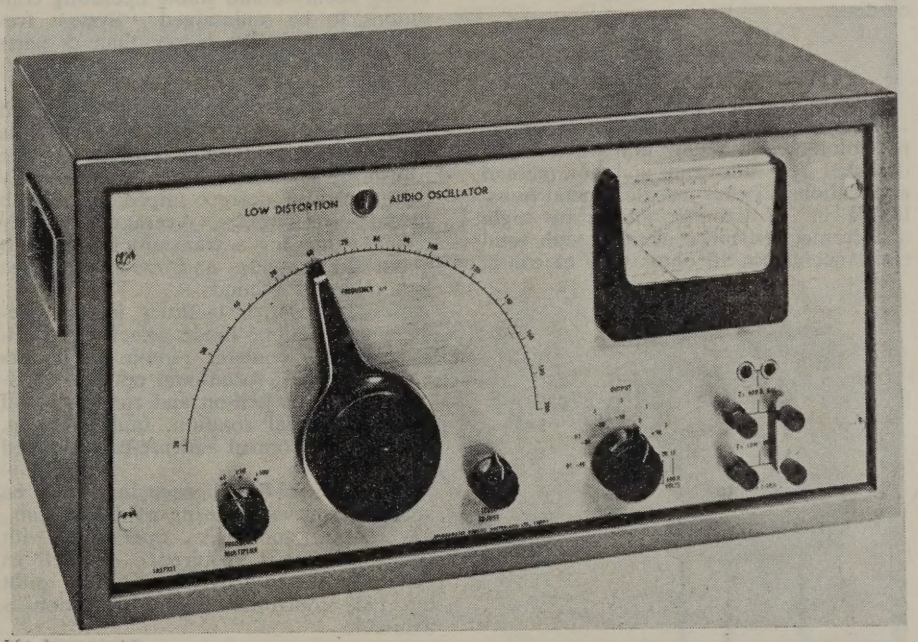
* * *

SIGNAL GENERATOR FOR THE SHF RANGE

The new SHF power signal generator SLRC developed by Rohde & Schwarz is the first signal generator to deliver 3 W in the wide frequency range from 2.3 to 7 G. c/s. The signal generator, which uses a disc-seal triode, can be pulse-modulated and frequency-synochronized, is outstanding for its high short-term and long-term stability of its typical characteristics. Thus it finds universal application in research and development work of the microwave technology.

The entire frequency range (1 : 3) is covered by the new signal and through single-knob tuning (coarse/fine drive) in one range. Frequency setting can be read with an accuracy of ±1.5% from the figures of a counter. The frequency-linear tuning characteristics permit a time-linear frequency sweep if a motor shaft is connected to the flange of the tuning knob. Internal 100 per cent pulse modulation of the output signal is possible with a repetition frequency of 1000 c/s ±0.5% (square wave) and externally in the repetition frequency range 0 to 100 kc/s. The output is indicated from —3 to +36 dBm on a calibrated meter. Repeatability of power settings lower than the above values is feasible with the aid of a non-calibrated scale indicating the adjustment of an attenuator. To satisfy special requirements on frequency purity and stability this signal generator can be synochronised with a frequency derived from a crystal with the aid of newly developed auxiliary units.

ENQUIRY 207



AUDIO-FREQUENCY OSCILLATOR

The AWA low distortion audio oscillator, type 1A57321, is an extremely stable resistance-capacitance oscillator intended for use on high-quality audio circuits or wherever high stability and purity of waveform are essential.

The equipment is available as a rack mounting unit fitted with a ventilated dust cover, or as a portable unit in a ventilated steel case.

Constructed on an anodised, aluminium chassis it has a stainless steel front panel on which all controls, meter, and output terminals are mounted. A socket fitted to the rear of the unit may also be used to connect the output voltage to other equipments.

The oscillator has inherently high stability over long periods of time and produces an exceptionally pure sine-waveform. This is achieved by using components with low temperature-coefficients as a Wienbridge network in a stabilised a-g-c amplifier. The output of the oscillator is coupled via a level control to a two-stage negative-feedback amplifier.

A low-impedance unbalanced output is obtainable directly from the amplifier. In addition, a transformer matches the amplifier output to a 600-ohms resistive load via a 0-60dB attenuator.

A meter indicates the output level from the balanced source into a 600-ohm resistive load in dbm and in volts r.m.s. The level from the unbalanced source may be read on a separate scale in volts r.m.s.

ENQUIRY 189

AMPLIFIER-MULTIPLIER

A new Ku frequency band solid-state amplifier-multiplier, designed for use as a radio-frequency source in airborne navigational systems, is available from the Westinghouse Electronic Tube Division. The compact tube, designated WX-30133, features conduction cooling and an output response which is flat over a 0.5 percent frequency range.

It produces a minimum of 100 milliwatts at 13.3 gigacycles by multiplying a 92-megacycle, 3-milliwatt input signal by a factor of 144. D-c input power is presently 50 watts and will be reduced in future models. The unit measures 2½ inches by 2 inches by 4½ inches and weighs two pounds.

ENQUIRY 156

* * *

NEW TAPES FROM OLD

A simple device for erasing a recording from a tape in a matter of seconds, is being produced by a British firm. It consists of a small box, containing demagnetising windings energised by mains power, with an insulated deck and a vertical spindle. When the tape is placed on the spindle and rotated twice in each direction, the tape is cleared of all recordings.

ENQUIRY 181

* * *

COMMERCIAL TRIMMING POTENTIOMETER

The model 62P Helitrim trimming potentiometer is a new miniature model designed for industrial and commercial applications. It has a sealed metal housing, ¼ in. in diameter and ¼ in. high, and cermet resistance element with total resistances from 10 ohms to 1 megohm.

The Model 62P has a power rating of 0.5 watts at 70°C and an ambient temperature range of –25 to 125°C. Single-unit price is expected to be less than £1 in New Zealand.

ENQUIRY 201

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AUTOMATIC REMOTELY CONTROLLED COMMUNICATIONS SYSTEM

A fully automatic high-frequency single sideband communications system —known as Speedrace—which can be controlled remotely by any form of digital data link over distances as great as 1,000 miles, has been introduced.

For long and medium distance point to point, ground to air or ship to shore communications, Speedrace is ideal for military use as all units have been designed to British defence specifications for construction, environmental performance and climatic conditions. It is also suitable for telecommunication authorities and for civil uses.

A number of technical advantages are offered by s.s.b. (single sideband) operation compared with double sideband (d.s.b.) over the same circuit. Single sideband transmissions occupy only half the bandwidth of d.s.b. operation, giving greatly improved efficiency, and approximately one-tenth of the power of a d.s.b. transmitter will give equivalent communications efficiency.

Now in quantity production for British and overseas governments, Speedrace has been developed over a number of years and is based on an analysis of user requirements. Systems are available with up to 10 kW p.e.p. output in static, transportable or mobile form. All modes of operation are available in the frequency range 2 - 30 Mc/s.

The heart of the system is a synthesizer, which accepts a standard frequency signal and produces 280,000 possible operating frequencies of unsurpassed accuracy and stability each separated by 100 c/s. Each output frequency is controlled by a frequency standard enabling accurate and stable operating conditions to be maintained. System frequency stability is better than 5 parts in 10^{10} per day, and accuracy is better than 1 part in 10^9.

All tuning, frequency setting and mode-setting is completely automatic, as are the output loading circuits of the transmitter, which are continuously maintained at correct impedance match to the aerial circuits. Average frequency change time for a transmitter system is about 20 seconds, and maximum time less than 45 seconds.

Remote control facilities include frequency selection, mode selection, transmit/standby control, remote oscillators and switching. Additional optional facilities include switch-on and run-up, aerial selection, aerial rotation, fault warning, remote gain control and pre-programmed systems.

Any type of intelligence input can be accepted, provision being made for a.m., c.w., s.s.b., and f.s.k., operation, with receiver a.f.c. if required. As well as fully suppressed carrier operation, pilot or voice controlled carrier operation is available.

ENQUIRY 187

* * *

NEW VHF MICROVOLTMETER

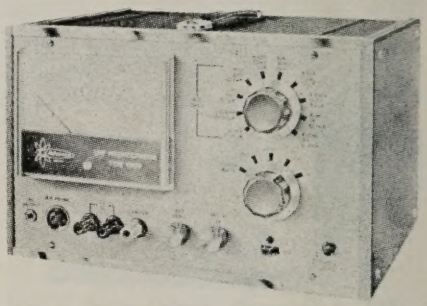
A new selective microvoltmeter type USVV for 10 μV up to 1 V, which is continuously adjustable from 30 to 480 Mc/s has been developed by Rohde and Schwarz.

The unit is suitable for such applications as measurements on filters or distortion factor measurements. Its frequency response is flat within 1 dB over the entire range. The bandwidth of the second IF is 300 Kc/s and that of the third 20 Kc/s. The built-in standardising oscillator, which can be switched off, permits the 2nd and the 3rd IF to be calibrated separately, one after the other. The unit can be automatically tuned for AM and FM operation and is equipped with a recorder output.

ENQUIRY 206

UHF MILLIVOLTMETER

Claimed to be the most versatile UHF millivoltmeter at its price on the market, the VM79 offers direct-reading drift-free measurement of voltage in the ranges 10mV FSD — 3V at frequencies from 100Kc/s - 1000Mc/s. In addition DC voltage measurements from 100μV FSD - 3V DC, current measurements down to 0.01μA FSD and resistance measurement to 10MΩ are included in the specification. As the latter has a polarising voltage of only 4V it is particularly suitable for use with transistor circuits.



Readings are indicated on a four-inch meter with separate scales for each facility. A DC output enables a suitable X-Y recorder to be coupled to the instrument for permanent records of measurements. The VM79 is battery operated by two 4V mercury cells and a third cell is used for resistance measurement. Battery levels may be checked on the front panel meter. A coaxial T-probe for 50Ω working is supplied with each millivoltmeter. A 75Ω probe, a high-impedance probe and termination for 75/50Ω working are available as optional extras.

The instrument is presented in the new Advance modular construction and is priced in the U.K. at £180.

ENQUIRY 203

* * *

MINIATURE SUPERCOOLER FOR ELECTRONIC COMPONENTS

A lightweight miniature gas liquefier has been produced for rapid local supercooling of components in electronics systems. Only 1.7 ins. long and 0.28 ins. in diameter, the cryogenic device has already been used successfully for cooling infra-red detectors, injection lasers, parametric amplifiers and photo cathode tubes — devices used in applications as different as space systems and brain surgery. The liquefier converts high pressure, clean gas, such as nitrogen, argon and air to its liquid phase and to temperatures down to 77 degrees Kelvin, often in a few seconds. The design of the miniature cooler enables the gas storage system to be remote from the device being cooled. Weight of the cooler is only 0.2 oz. The gas then passes through the heat exchanger so that its cooling effect is applied to incoming gas. This process is cumulative until liquefaction occurs at the nozzle and the liquid collects in a cold chamber. The complete system is insulated from external temperatures by an evacuated double-glass walled enclosure (a dewar) which also usually houses the device to be cooled.

ENQUIRY 200

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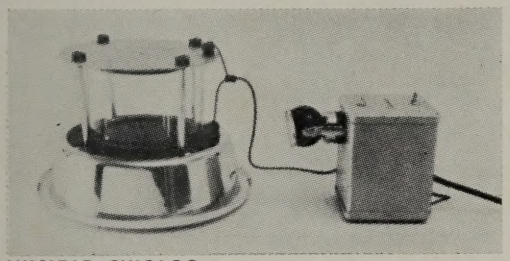
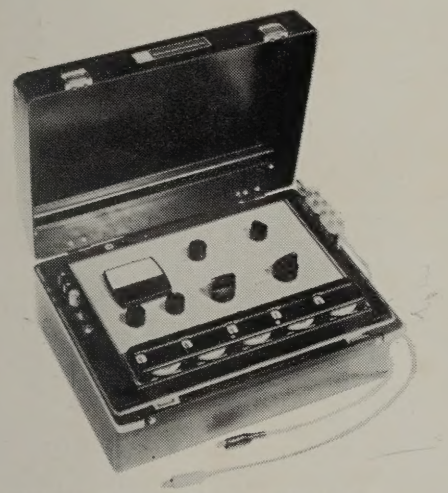
ENQUIRY CARD AD. 21

focus on our agencies



NUCLEAR CHICAGO

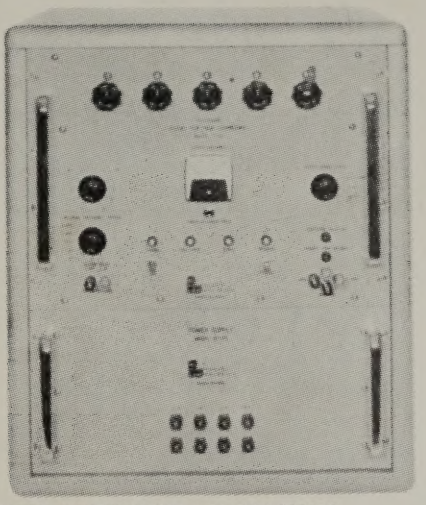
Next to the gold-leaf electroscope, probably the most effective basic device for observing ionizing radiation is the cloud chamber. The Nuclear-Chicago Model 6310 Cloudmaster is a continuously active cloud chamber system that provides dramatically impressive displays of alpha and beta radiations and gamma ray and cosmic ray interactions.



ELECTRO SCIENTIFIC INDUSTRIES INC.

Featuring an accuracy of 0.003%. This battery-operated d.c. voltmeter and voltage calibration system has been developed for use with voltage measuring and recording equipment.

Model 330 Portametric Voltmeter is ten times more accurate than most laboratory potentiometers.



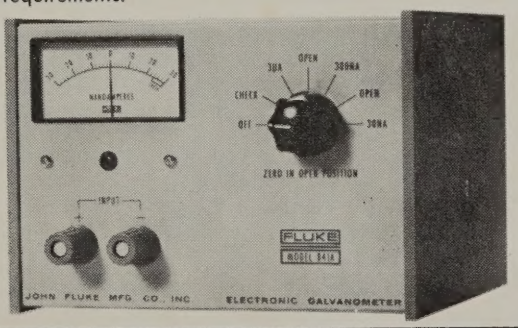
HOLT INSTRUMENT LABORATORIES

Audio voltage standard model 323A. Absolute accuracy —0.02%, distortion —0.035%, output power &30VA, voltage range .10MV to 1000 volts, frequency range 35 cps to 20 kc.

JOHN FLUKE MANUFACTURING CO. INC.

A rugged new solid state electronic galvanometer meeting mil-spec environmental parameters is now available by Fluke.

Features of the new design include sensitivity of 2 UA per scale division ability to take a million-to-one overload without damage and elimination of external damping requirements.



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TELEPHONE 565-361

SERVICE AND CALIBRATION FACILITIES AVAILABLE

ENQUIRY CARD AD. 22

Advance power supplies

Power Supply Unit PP1

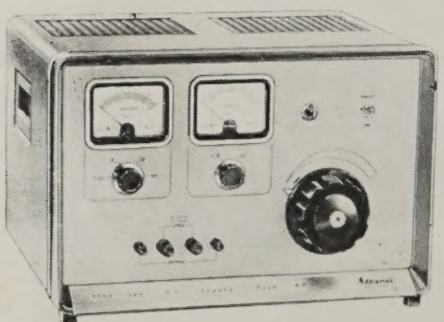
Input voltage 94 to 138V, 187 to 276V, 50c/s only. *Outputs*

Supply No.	*1*	*2*	*3*	*4*	*5 and 6*
Voltage	0 to 600V DC	+100 to +800V DC	−200V DC fixed	0 to −200V DC	6·3V AC (r.m.s.)
Maximum current	300mA total	300mA total	50mA	5mA	4A each
Maximum source impedance (ohms)	0·1 (DC) 0·5 (at 50kc/s)		0·1 (DC) 0·3 (at 30kc/s)	13K	
Maximum ripple voltage (r.m.s.)	3mV	3V	1mV	1mV	
Stabilisation factor within permissible mains variation	1000 : 1	4 : 1 essentially unstabilised	1000 : 1	1000 : 1	15 : 1
Short circuit protection	e.m. cut-out	e.m. cut-out	100MA fuse F.3		Stands brief short circuits

Special features *Variable source impedance* Source impedance of supply No. 1 variable from 0·1 to 40Ω. *Artificial ripple injection* (a) *Internal* 50c/s up to 6V. (b) *External* Up to 50kc/s from external generator working into 5Ω load. *Metering* Two meters are fitted. *Dimensions* 19¾in (50cm) wide × 13 in(33cm) high × 15in (38cm) deep. *Weight* 92 lb (42kg).

Power Supply Units PP2 PP4

Input voltage 100 to 125V, 200 to 250V, 50c/s only. *Output voltage* PP2 0 to 50V d.c., PP4 0 to 80V d.c. both continuously variable. *Current* PP2 0 to 10A, PP4 0 to 6A. *Impedance* Less than 0·25Ω up to 100kc/s (4-terminal output provided). *Resistance* Less than 0·003Ω. *Stabilisation* Input voltage variations of ±15% are permitted, stabilisation factor 5000: 1. *Ripple* Less than 2mV pk.pk. *Metering* Two meters are fitted.



PP2

PP2 Ammeter switched in four ranges as follows 0 to 0·3A, 0 to 1A, 0 to 3A, 0 to 10A. Voltmeter switched in two ranges as follows 0 to 6V, 0 to 60V.

PP4 Ammeter switched in four ranges 0 to 0·2A, 0 to 0·6A, 0 to 2A, 0 to 6A. Voltmeter switched in two ranges 0 to 10V, 0 to 100V. *Overload protection* Resettable cut-out operates when load current exceeds 125% of ammeter F.S.D.; cut-out occurs within 0·2ms of the overload. A thermal cut-out provides protection against excessive internal temperatures at maximum load. *Dimensions* 20¼in (51·4cm) wide × 13¼in (33·6cm) high × 16¼in (41·3cm) deep. *Weight* 140lb (63kg).

Power Supply Unit PP3

Input voltage 90 to 130V, 200 to 240V, 40 to 60c/s. *Output voltage* 0 to 30V d.c. in three ranges, 0 to 10V, 10 to 20V, 20 to 30V. *Current* 0 to 1A. *Impedance* (d.c.) Less than 0·01Ω. *Impedance* (a.c.) Less than 0·2Ω up to 100kc/s. *Ripple* Less than 0·5mV pk.pk. *Stabilisation* 7% supply variation varies output by approximately 10mV. *Metering* An ammeter and a voltmeter, switchable to either output. The ammeter has two ranges 0 to 0·1A F.S.D. and 0 to 1A F.S.D. *Overload protection* Resettable electronic cut-out. *Operating temperature* Up to 35°C (ambient). *Dimensions* 18in (46cm) wide × 13½in (33·5cm) high × 11½in (29cm) deep. *Weight* 38lb (17·25kg).

A Rack mounted version is also availabie– PP3R.

Power Supply Unit PP6

Input voltage 110, 120, 220, 240V ±15%, 50c/s only, 160W each section. *Output voltage* 0 to 30V in six overlapping ranges. *Current* 0 to 3A at any output voltage. *Impedance* (d.c.) Less than 0·02Ω; (a.c.) less than 0·2Ω up to 100kc/s. *Ripple* Less than 1mV pk.pk. *Stabilisation* 3000: 1 permits supply variations of ±15% above and below nominal value. *Metering* Two meters are fitted. An ammeter 0 to 0·1A, 0 to 0·3A, 0 to 1A and 0 to 3A F.S.D., and a voltmeter 0 to 30V. *Overload protection* Resettable electronic cut-outs adjusted to operate at 125% of F.S.D. on any current range. *Operating temperature* Up to 35°C (ambient) at full load.

Dimensions 20in (50·7cm) wide × 13in (33cm) high × 15in (38cm) deep. *Weight* 70lb (31·8kg).

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